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TRANSLATION OF SELECTED PORTIONS OF POLYGRAPH EXAMINATION METHODS BY THE JAPANESE NATIONAL POLICE AGENCY PSYCHOLOGICAL RESEARCH LABORATORY

September 8, 1993

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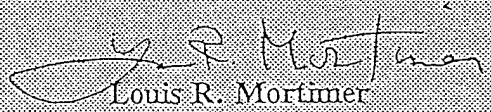

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PREFACE

This product is a full translation of the Japanese material provided.

TABLE OF CONTENTS

I. Emotion and Physiological Reactions

1. Physical changes that accompany emotion

We commonly experience various physical changes that accompany emotions in our daily life. When we are angry or ashamed our face reddens; when excited, our heart beats faster; when tense, our palms become wet. Severe attacks of fear cause a feeling of weakness at the knees, muscles all over the body twitch, the face turns pale, pupils dilate, the skin develops goose bumps, cold sweat flows, and one feels that one's heart may stop any moment. In a sustained emotional state such as worry or anguish, smiles disappear, we look glum and experience a loss of appetite, indigestion, headaches or heavy-headedness, stiff shoulders, or insomnia. Among women menstrual irregularities often occur.

As seen above, various behavioral and physiological reactions are observed to accompany mental, especially emotional, changes. Such physical symptoms include not only externally observable physical changes, but also those of chemical components of blood or of electric resistance of the skin. In particular, physical changes elicited by emotion are mostly based on functional changes in organs controlled by the autonomic nervous system: heart, blood vessels, various secretory glands, and other internal organs.

2. Breathing

A subject's respiratory movement, one of the measures used in polygraph testing, is recorded as respiratory waves using respiratory tubes. Respiratory movement is defined as the repeated expansion and contraction of the chest cavity caused by movement of the diaphragm and intercostal muscles. With the expansion of the chest cavity the lungs inflate as the external air is inhaled via the air passage. This movement is called inhaling. In contrast, the lungs deflate as the chest cavity contracts when the air inside the lungs is exhaled. This movement is called exhaling. Respiratory movement consists of rhythmic alternation of inhaling and exhaling.

Breathing is classed into two principal types: Breathing mostly effected by movement of the diaphragm is called abdominal breathing; breathing mostly by movement of the intercostal muscles, thoracic breathing. In the normal respiratory state, one of these movements dominates. When the leading respiratory movement cannot be ascertained it is called thoracic/abdominal breathing. In humans in resting condition abdominal breathing dominates. When weakened by disease or when in the state of extreme fatigue, thoracic breathing dominates.

Respiratory rate is defined as cycles/minute of inhaling and exhaling. With infants, the count is as high as 40-60 cycles a minute. The standard rate with people above 8-9 years of age in the resting

condition is 17-18. Posture also influences respiratory rate: approximately 17 when lying and 20, when standing up. The rate increases when walking or running.

2.1 Emotion and respiration

2.1.1 Changes in respiratory movement

(1) The rhythm of respiratory movement is stable for a person, and as long as there is no change in mental or physical condition does not change markedly. When external stimuli induce emotion, however, the respiratory rhythm becomes unstable. In particular, changes in the respiratory rate and the respiratory volume per cycle occur. With increase in the respiratory volume, the amplitude of respiratory waves increases. This is called deep breathing. In contrast, small respiratory volume as reflected in the small amplitude of respiratory cycles, is called shallow breathing.

Changes in respiratory movement take many forms. For example, the expression, "breathtaking moment," describes the very short state of hardly any breathing, an almost motionless sense of heightening tension before moving onto the next movement. Also a "sigh" is an expression of a heavy mood and a feeling of depression expressed in the form of a long breath.

(2) Close relationships between emotion and changes in respiratory

movement have been clearly demonstrated; and the main relationships are demonstrated as follows:

1. When tense, an increase in respiratory rate as well as shallowing of breathing are observed when compared to that of the resting state.

2. Increase in the respiratory rate and deepening of breathing are observed to accompany anxiety or anger.

3. Anger is accompanied by shallow breathing as well as by a decrease in respiratory rate. Further, shallow breathing and a decrease in respiratory rate tend to accompany feelings of gloom and sadness.

4. With feelings of self-reproach, shallow and deep breathing alternate, accompanied by an irregular respiratory rate.

5. With psychological shock and surprise, the depth of breathing is unchanged, while an increased respiratory rate indicates an irregularity.

2.2 Measurement of respiratory movements

2.2.1 Sensors used in measurement

(1) Methods of measurement for respiratory movement include: applying a standard voltage to an elastic rubber tube that encloses liquid zinc

sulfate and recording changes in impedance between two electrodes attached to the subject's chest. The former is especially well utilized in experiments.

2.2.2 Respiratory cycle

(1) When a subject inhales air and his thorax expands, the respiratory tube is stretched, resulting in reduction of pressure to the sealed air. The respiratory wave is recorded as a rising curve. When the air is discharged, the thorax contracts correspondingly and pressure to the sealed air increases. This respiratory wave is recorded as a falling curve. This forms one respiratory cycle.

(2) Figure 1 represents one respiratory cycle. The time required to complete one cycle is shown as "a," "b" is the time from the beginning to the end of inhaling, and "c" is the time from the beginning to the end of exhaling. The length of "d" represents the depth of breathing.

[Key to Fig. 1: Respiratory cycle]

Since records taken using a pneumograph tube represent only relative values of the depth of breathing, comparison is feasible within a continuous tracing of the same individual. However, data on respiratory cycles are of relatively high accuracy.

2.2.3 Respiratory rate

When sitting in a chair in a comfortable position, the respiratory rate for most people is in the range 18 plus or minus 5 [13-23.] However, some obese people may record more than 25 times per minute. This is because their breathing tends to be shallow so that in order to inhale a set volume of air they need to breathe more often compared to persons of normal body shape. Except for such cases, if a subject's respiratory rate deviates greatly from the standard rate, it should be suspected that the subject may intentionally be controlling his or her respiratory rate.

2.2.4 Conditions for optimal recording

(1) The fewer layers of clothing between the subject's chest and the respiratory tube, the better the recording. The preferred place to attach the respiratory tube, in the case of a male subject, is directly over his shirt; for a female subject, over her blouse.

(2) The respiratory tube should be attached as closely as possible to subjects' chest. Whatever prevents contact must be removed as much as possible. It is not desirable for a respiratory tube to be placed over a man's tie pin or a woman's large brooch. Likewise, the respiratory tube is to be attached after having the subject empty his chest pocket of such contents as a cigarette case, a fountain pen, or eye glasses.

(3) The respiratory tube is attached to a set position on the

subject's chest. It must be securely attached and adjusted to the anchoring chain in order to avoid shifts of the tube during the presentation of questions. However, excessive tightening of the anchoring chain is not desirable. Especially with lean males, a strapping string should also be used, since the anchoring chain alone does not guarantee stable positioning.

2.2.5 Positioning the subject

During the interview that precedes the presentation of questions, subjects may take comfortable positions, crossing their legs or hunching their backs. Once the recording begins, however, the subject is requested to straighten his back and place both feet on the floor. This request is intended to prevent problems in recording respiratory waves, especially shifts of the baseline, that can be caused by movement of the respiratory tube.

2.2.6 Standard recording

Each person has a respiratory rhythm unique to the individual. Therefore prior to questioning it is necessary to obtain a record of standard respiratory waves of the person. After the respiratory tube is attached, a subject is requested to sit properly and look straight ahead.

Respiratory waves are recorded for three to five minutes after the

subject is told to "Please remain seated and maintain your present posture in a relaxed mood, while the equipment is being adjusted." After obtaining a stable baseline, uniform amplitude, and stable respiratory waves, this record is used as the standard control for that person.

2.3 Evaluation of the record of responses

2.3.1 Patterns of responses

Respiratory wave response patterns are classified into three general categories: shifting baseline, suppressed amplitude, and overall confusion. However, it has not been ascertained which pattern indicates the strongest emotive changes. However, it can be said that suppressed responses appear with a relatively high frequency and are easy to use as an evaluating reference.

2.3.2 Shifts in the baseline

With respiratory waves recorded in a normal state, initial and final points of a respiratory cycle rest on a horizontal line. If amplitudes are roughly uniform, a horizontal baseline is seen in the record of repetitive respiratory movements as shown in Figure 2a.

[Key to Fig. 2: Shifts of the baseline]

2.3.3 Suppression

A suppressed response is defined as diminished amplitude of respiratory waves. It can follow various patterns. Figure 3 is an example of such a pattern called step control. Amplitudes diminish and recover in steps.

[Key to Fig. 3: Step suppression]

Figure 4 indicates abruptly diminished amplitude, maintenance of the same amplitude for several cycles, and the immediately following suddenly enlarged amplitude required to compensate for insufficient air supply.

[Key to Fig. 4: Suppression]

An extreme example of this suppressed response is a block. As is seen in Figure 5, the baseline rises at the beginning of a block at the end point of inhalation.

[Key to Fig. 5: Block]

2.3.4 Confusion

A mixture of shifting baseline and suppression is recorded. Attention should be paid to this because confusion in the respiratory waves may

often appear as the result of a subject's intentional obstructive behavior.

[Key to Fig. 6: Confusion]

3. Electrodermal response

When electric current of the order of μA runs between electrodes attached to two points on the skin, the value of the electric current through the body stabilizes within several seconds. The apparent resistance measured at this point is called the basal resistance. If a subject is exposed to a stimulus, such as a high pitched sound [or a loud noise] or a strong light without warning, the magnitude of the electric current grows rapidly after a latency of 1-3 seconds. After several seconds, the resistance between the electrodes returns to the pre-stimulation level. This transient change is called the galvanic skin response (GSR).

The method of measuring skin resistance and its transient change by running a weak electric current (10-50 μA) between electrodes is called the electric charge method. Another method of measuring GSR is called the electric potential method, which measures the difference in electric potential between two points on the skin.

3.1 Emotion and the GSR

3.1.1 Psychological stimulation

(1) A GSR is observed when a subject is exposed to an unpleasant stimulus such as a light electric shock. An electric shock gives a subject a definite sense of pain. The response to this stimulus manifests itself as a transient decrease of skin resistance accompanying the emotive response of unpleasantness or fear elicited by pain.

(2) Words used in daily life also serve as stimuli. Response to such common words as desk and pencil are observed. The size of transient changes in skin resistance differ depending on the meaning of the word. Especially large is the size of change in response to socially taboo words. Responses to such words do not easily habituate after repetitive presentation.

3.1.2 Physical stimulus

(1) A GSR appears when a subject is exposed for several seconds to a sound that does not produce an unpleasant sensation. After repeated exposure to the sound, response size decreases steadily and disappears at the end.

(2) A sound is presented to a subject combined with an electric shock. Because an electric shock elicits a far stronger emotion than a sound, the diminishing response is gradual. After repeating the

procedure of presenting a sound immediately followed by an electric shock, the sound alone can elicit a GSR of the same magnitude as when it is followed by an electric shock. This is the simplest case of "conditioning" making use of GSR as a measure.

3.2 Measurement of GSRs

3.2.1 Induced responses vs spontaneous responses

(1) While recording with electrodes in place on the fingertips or on the palms, GSR may frequently be observed despite the absence of stimuli such as a question. This is a response elicited from, for example, the subject's own psychological uneasiness. A response that does not have corresponding test stimulus is called spontaneous GSR.

(2) If the test room is in proper condition (e.g. soundproofed), a spontaneous GSR usually disappears within several minutes. Spontaneous GSRs do not easily disappear if the test room is imperfect (such as noise from outside) or if the subject is excited. Attempts should be made to move to a quiet room or allay a subject's anxiety through small talk.

(3) A GSR that serves as a measure of a polygraph test contributing to the evaluation appears as a response to a question and is different from spontaneous GSR. This is called an induced GSR as distinct from a spontaneous GSR.

3.2.2 Gradual Decrease

The size of GSR depends on the type and strength of the stimuli used. For instance, the types of stimuli assumed to be emotive, such as high pitched sounds [or loud noises], mental tasks such as mental calculation, requests to say a word that first comes to the subject's mind in response to the word presented, or light electric shocks, elicit relatively large GSRs. However, no proportionately linear relationship exists between the strength of stimuli and the size of the GSR. Stimuli that elicit large GSRs at the beginning become less effective after repeated presentations with GSRs diminishing. Finally no GSR appears at all. This phenomenon is called gradual decrease (adaptation or habituation.)

3.2.3 Mechanism of GSR Manifestation

(1) The following three theories are attempts to identify peripheral effectors directly related to the manifestation of GSRs.

1. Muscular theory: Muscular activities are relevant
2. Blood vessel theory: Contraction and expansion of blood vessels are relevant
3. Endocrine theory: Activities of sweat glands are relevant

At present the theory that maintains the activity of secretion by sweat glands as being the most relevant enjoys the broadest support.

(2) However, GSR is not directly related to perspiration, but to the presecretory activity of the cellular membranes of the sweat glands. Namely, excitation of a sweat gland increases the ionic permeability of cellar membrane. As a result, ions flow more easily which in turn lowers the skin's resistance.

3.2.4 Polarization

(1) Passing an electric current causes a chemical change at the boundary of an electrode and electrolyte (glue applied at an electrode.) This phenomenon is due to electric conduction caused by ions that travel to the opposite electrode. As electric current passes through the electrode, ions accumulate there, resulting in the generation of reverse electric current. Therefore, the apparent resistance between electrodes is enhanced.

(2) When no electrolyte is applied and dry electrodes are used, a problem different from the above (1) arises. When a subject sweats, sweat itself contains salt, an electrolyte in itself, so that the area of contact of electrodes changes with time, with the result that apparent skin resistance fluctuates.

(3) Relationship to atmospheric temperature

When the temperature rises base resistance tends to fall. Especially when room temperature goes above 30 degrees Celsius, base resistance

decreases drastically. GSRs under the state of decreased base resistance show large amplitudes in response to stimulus presentation. Their frequency of appearance also increases.

(2) With rising temperature, the time between stimulus presentation and response, namely latency, becomes shorter.

3.3 Evaluation of GSR records

3.3.1 Characteristics of GSRs

(1) For a measure in polygraphic testing to be effective, it must be able to clearly distinguish between false responses and true answers. Characteristics of GSRs satisfy this condition.

(2) The polygraph test consists of the presentation of a series of questions to a subject and the comparison of responses to each question in the series. Therefore, characteristics of GSRs that indicate sufficient suitability to be used as measures in polygraph tests include the following:

1. The GSR is sensitive to stimuli within a wide range of response magnitude.
2. Measurement of the GSR is easy; quantification is possible
3. The GSR is an involuntary response so that it is extremely difficult to control it intentionally.

4. Both latency and duration are short, making the distinction between them clearcut.

3.3.2 Response patterns

(1) The arrow in Figure 7 indicates the position of a critical question. The size of the emerging response indicates the magnitude of emotion elicited in the subject by the question. Such a response is obvious and easy to evaluate.

[Key to Fig. 7: A typical response]

(2) The GSR in Figure 8 appears to be active throughout the record. In this record, it is impossible to distinguish the response to the question. Evaluation based on this type of response pattern is extremely difficult.

(3) GSR can be elicited by stimuli other than questions. A deep breathing elicited the prominent response seen in Figure 9.

[Fig. 9: A response elicited by deep breathing]

4. Cardiovascular Functions

4.1 Emotion and Cardiovascular Functions

People in olden times appeared to have considered the heart to be the site where spirit resides; they based their belief that mental activity was closely related to the heartbeat on empirical knowledge. In fact, the spirit does not reside in the heart. Nevertheless, the heart is an organ that reflects mental activity with utmost sensitivity. Other body organs under the control of the autonomic nervous system also show changes that respond to various emotions such as happiness, anger, sadness, pleasure, anxiety, or fear. When compared to other organs, cardiovascular system functions are especially closely related to emotions.

The center of cardiovascular functions is the heart. Through repeated contractions and expansions, the heart plays the role of a pump. When the pressure, produced by the pulsation, sends blood into the main artery, the arterial wall stretches, causing the vessel to expand. The wavelike shift of changing pressure caused by heightened pressure and expanding vessel travels along the arterial wall, gradually diminishing in strength from heart to periphery. This arterial movement is called the pulse.

Blood sent out by the pumping movement is temporarily stored in the expanded part of the blood vessel. As the expanded wall contracts because of its elasticity, blood is pushed toward the periphery, forcing the neighboring part of the blood vessel wall to expand. This phenomenon of blood traveling in blood vessels in a wavelike fashion is called the pulse wave.

Blood sent out from the heart into the artery exerts a fairly high pressure on the blood vessel. This is because the artery has to accommodate more blood than its normal volume and feels tension from the elasticity of the expanded arterial wall as it presses against the blood. This pressure is called blood pressure.

The cardiovascular system described above responds in various ways to the changes that accompany mental activity, including increase in pulse or rising blood pressure. The adjustment of such a function is mainly under the control of the autonomic nervous system and is performed unconsciously, involuntarily, and incessantly. Generally speaking, the sympathetic nerves of the autonomic nervous system facilitate cardiac functions, while the vagus nerve, a part of the parasympathetic nerve, inhibits them. If the effect of one nerve weakens, the other becomes dominant, which results in changes in the function of the cardiovascular system. In a condition free from internal or external stress (a restful state), the vagus nerve is in charge of adjustment. The harmonious working of these mutually opposing nerves controls cardiovascular functions. Facilitation and inhibition of the cardiac vessels are controlled through a center located in the medulla oblongata. Cardiovascular functions can act as sensitive indicators of mental activity because of controlling mechanisms described above as well as the fact that they are all over the body.

Cardiovascular functions are indicated by such means as heart beat,

blood pressure, and pulse waves. The following is an outline of measuring methods for these indicators:

4.2 Measurement of pulse wave

4.2.1 Pulse wave

When blood enters the artery, blood pressure inside the artery rises. Because every arterial wall is elastic as well as expandable, the pressure against the vessel's inner wall rises as blood, pushed out of the heart, is injected into the artery. This local expansion and the rise of inner pressure travels wavelike within the entire arterial system toward the periphery. This wave is called the pulse wave.

The pulse wave is one of the important measures of the cardiovascular system representing a part of the motile response of blood vessels. The following are typical methods of measuring pulse waves:

(1) Mechanical method: This is a method that records changes in the volume of an arm or a fingertip brought about by changes in the volume of circulating blood. The arm or fingertip is encased in a container filled with air or water. Changes in the volume of air or water are recorded.

(2) Impedance method: Electrodes are attached at two points along the edge of the place where the measurements are to be made. Changes

in the impedance between the electrodes indicate changes in the volume of body tissue.

(3) Photoelectric plethysmograph: Light is applied to the body part to be measured. The ratio of transmitted light vs. reflected light is determined.

Other methods include: conversion into changes in electrical resistance of changes in the circumference of a limb or fingertip associated with changes in the volume of body tissue; measurement with a strain gauge of changes in pressure caused by changes in the volume of the measured body part. Generally, photoelectric plethysmography is the most commonly used technique, because of its ease of handling as well as wide applicability.

There are two types of photoelectric plethysmograph, transmitting and reflective (Figure 10.) Both types make use of the fact that a fraction of the light illuminating the tissue is absorbed by the blood vessels. Change in transmitted or reflected light is converted photoelectrically, then amplified and recorded.

[Key to Fig. 10: Photoelectric plethysmograph sensors

1. Light source
2. Light sensor
3. Transmitting type
4. Reflective type]

Sensors usually are attached to fingertips or earlobes. Sensors are easily attached at these places where blood vessels are well developed to prominently display changes in volume. Wave amplitudes change greatly depending on the pressure exerted against the skin when sensors are pressed on. The maximum amplitude is usually obtained when a sensor presses the skin at a pressure within the range of 20-60 $mmHg/cm^2$. Figure 11 shows a photoelectric plethysmograph record of pulse waves. The shape of the waves basically remains the same no matter what method is used to measure them.

Generally pulse wave response to external stimuli is two dimensional, shift of baseline and change in amplitude. At the presentation of stimuli the baseline shifts after certain latency and at the same time amplitude decreases. The degree of changes in amplitude and shifts in baseline differ depending on the type and intensity of stimuli as well as the level of the subject's wakefulness. However, these fluctuations occasionally appear in the absence of any external stimulus in the form of respiratory changes. Respiratory changes take the form of periodic changes; the baseline rises and falls, somewhat trailing inhaling and exhaling, respectively. Further, following a deep breath or a sigh drastic lowering of the baseline is observed. In addition, fluctuations that reflect the subject's level of wakefulness come into the picture. Generally, while a subject is asleep the amplitude of pulse waves tends to be large and is accompanied by a high and spontaneously undulating baseline; this gradually becomes smaller as the level of wakefulness rises; at the

same time, the frequency of spontaneous baseline shifts increases. When a subject is tense, the amplitude of pulse waves diminishes and the response also is characterized by irregular baseline shifts.

Pulse waves measurements are done from the following four perspectives. Attention should be paid in quantitative measurement of baseline shifts to the fact that the time constant inherent to the amplifier being used distorts the shape of the wave form.

(1) Degree of decrease in amplitude: Amplitude is defined as the length of a line drawn perpendicularly from the peak of a wave to the line that connects the bottom of two neighboring waves; this length indicates the degree of decrease.

(2) Degree of baseline shift: The baseline is the line that connects the bottom of each pulse wave. Movement of this line denotes the degree of shift.

(3) Magnitude of decrease in amplitude: The decrease of amplitudes within a preset time period reveals its quantitative change. One example of such a measure is the area beneath the curve obtained by connecting the bottom of each pulse wave within a set time period after the presentation of stimulus, i.e., the integral of the curve.

(4) Amount of baseline shift: The shift within a set time period is expressed as its quantitative change. One example is measuring the

area between the line that connects the bottom of the pulse wave at the time of stimulus presentation with the bottom at the time of post-stimulation recovery to the baseline, and the curve that connects the bottom of each wave.

The following is an outline of the pulse wave as it is used in the present polygraph test. The devices used in measurement will be explained in Section 6, Devices for the Measurement of Pulse Waves, of Part III, Devices.

One of the indicators that the present polygraph machine uses in detecting falsehood, is a curve obtained by applying pressure through the cuff, attached at the upper arm, at a point between the maximum and the minimum blood pressure. While this measure has been called the "cardiac pulse wave," what this method actually measures are chiefly pulse waves that reflect interaction between blood pressure and changes in the volume of the arm. The term "cardiac pulse wave" is seldom used in the fields of psychology or physiology. Therefore, in this work, the phenomenon measured by this method is called the pulse wave.

A common standard for judging pulse waves that have occurred in response to a false answer is a rising baseline (Figure 12). The baseline shift of a pulse wave is considered to reflect increase/decrease in the volume of blood flow caused by changing blood pressure. When an emotive stimulus facilitates activities controlled

by the sympathetic nervous system, blood vessels that supply blood to the skin and internal organs contract. Simultaneously, blood vessels that supply blood to skeletal muscles expand. Increases in the volume of upper arm muscle tissue (approximately 85 % consist of skeletal muscles), due to increased blood flow, explains at least a part of the rise in cuff-pressure (indicated as rising pulse wave baseline) observed in response to false answers.

[Key to Fig. 12: An example of rise in pulse wave baseline]

The cuff typically is placed at the upper part of the favored arm. The application of a cuff-pressure about 3 mmHg above the minimum blood pressure is considered to yield the clearest records. The optimal amplitude for the present polygraphic device is about 20 mm. If the pneumatic pressure inside the cuff is too low, m-type waves appear; if too high, the lower part of waves disappear (Figure 13).

[Key to Fig. 13: Relationship between applied pressure to the cuff and wave types

1. Too low a pressure (55 mmHg applied)
2. Optimal record (80 mmHg applied)
3. Too high a pressure (115 mmHG applied)

4.2.2 Other principal indicators

(1) Heartbeat: The most commonly used device for the measurement of

heartbeat is electrocardiogram (ECG [EKG]). EKGs usually use the 4-limb conduction method involving the left foot and both hands; another method involves the thoracic wall. The following is a list of combination (standard conduction) employed in the 4-limb conduction method.

First conduction method: Right hand--left hand
Second conduction method: Right hand--left foot
Third conduction method: Left hand--left foot

The EKG is the record of amplified differences in electric potential between two electrodes caused by cardiac activity. The standard unit of an EKG record is 1 mV/cm. The equipment for recording EKG is called the electrocardiometer.

Fig. 14 indicates three standard conduction methods and records obtained by using each method. The basic EKG consists of wave types named PQRST: P is related to activities of atria, combined QRS, to excitement of ventricles, and T, to ventricular contraction. The R wave, the most prominent in the normal EKG, is recorded using the second conduction method with an electric potential of approximately 2 mV.

[Key to Fig. 14: EKG examples recorded using standard conduction methods
1. The first conduction method: 1-1, right hand; 1-2, left

hand; 1-3, right foot; 1-4, left foot

2. The second conduction method: 2-1, right hand; 2-2, left hand; 2-3, right foot; 2-4 left foot

3. The third conduction method: 3-1, right hand; 3-2, left hand; 3-3, right foot; 3-4, left foot

4. Position of electrodes

5. Recorded EKG]

The EKG contains a great deal of information. In considering changes in a relatively long period, the number of R-waves is counted to calculate the average heart rate per minute. However, for the analysis of vast quantities of data or to visualize momentary changes, the cardiotachometer is a convenient device that allows the continuous recording of serial changes in each heartbeat (R-R interval.) Figure 15 is an example of a record, generally known as cardiotachogram, recorded by this equipment. A cardiotachogram instantly displays the interval between heartbeats in terms of heartbeats per minute and is quite easily interpreted.

[Key to Fig. 15: A Sample Cardiotachograph Record

1. Heartbeat/minute
2. 5 seconds]

The nocturnal heartbeat is markedly slower than that during daytime. Heartbeat also is influenced by breathing, faster when exhaling and slower when inhaling. Because of the multiple effects of various periodic fluctuations, the heartbeat changes from moment to moment. It should be noted that any change due to stimuli or experimental handling is superimposed on these basic changes. The range of heartbeat change is not so great. It is rare to see a person whose heartbeat rate is less than 50/minute or more than 150/minute under any conditions. However, considerable variations occur within this range. When heartrates for several persons are measured and records of the persons who have showed the maximum and minimum values are compared, a difference of 30 beats/minute is not rare. It also is not unusual to find persons whose heartbeat in the resting condition changes on the average 10 beats/minute.

(2) Blood pressure: Blood circulation in the body is maintained by the blood the heart sends out to tissues via the arterial system. The heart generates the pulsation that discharges blood intermittently.

The arterial system acts as a cushion for the heart's pulsating generating power. That is, the elastic arterial wall absorbs and stores the pressing energy caused by the contraction of the heart (the driving [systolic] phase of the heartbeat); during the period of an expanding heart (the slackening [diastolic] phase) pressure is maintained through the recovery of this stored energy. The arterial pressure generated in this way is displayed as the type of wave shown

in Figure 16. The value S at the peak of the wave is called the maximum blood pressure (or blood pressure during the contracting phase; systolic blood pressure). The value D, the depression between two waves, is called the minimum blood pressure (or blood pressure during the expanding phase; diastolic blood pressure.) The difference between these two values is called the pulse pressure.

[Fig. 16: Blood Pressure Curve Measured by Directly Inserting a Cannula into a Blood Vessel

1. Time
2. Pressure mmHg
3. 5 seconds]

Methods of measuring blood pressure include the direct method (or blood-viewing method [not identified]) and the indirect method (non-blood-viewing method [not identified.]) In the former, a cannula is inserted directly into an artery to measure the inner pressure. In the latter, blood pressure is inferred from the external pressure required to stop the blood flow in the vessel. Direct measurement of the arterial pressure, although highly accurate, is not appropriate for humans. Therefore, the latter method is generally used. The simplest method employs a mercury hemanodianamometer.

Other indirect methods of blood pressure measurement include palpation and the use of a stethoscope. In palpation, the arm-cuff (manchette) is inflated to increase the pressure, and the pulse at the wrist is

felt until it can no longer be felt. Then the pressure is gradually decreased. The maximum blood pressure is defined as the pressure when the pulse was first felt. With this method, however, minimum blood pressure is hard to measure so that the use of a stethoscope is more general.

Stethoscope is applied to the brachial artery of the elbow joint of the arm where the cuff is worn. While listening to the sound of blood circulation (swirling sound,) the internal pressure of the cuff is raised to block the blood flow until the sound disappears. When that point is reached, cuff-pressure is generally lowered until a faint, clear sound begins to be heard. The maximum blood pressure is the value of pressure at this point. With further reduction of the cuff-pressure, the sound disappears again. The pressure at this point is the minimum blood pressure.

Blood pressure weakens as the distance from the heart increases. For instance, the maximum blood pressure of a male in his twenties is 130-140 mmHg at the aorta, 90 mmHg at a finger artery, 20-45 mmHg at an arteriole, and 20 mmHg at a capillary vessel. The maximum blood pressure gradually increases with age. When the maximum blood pressure of a 20 years old male is 120 mmHg, the standard increment is 1 mmHg for every 2 additional years. The average value for each age group is conventionally considered to be within the range of plus/minus 10 mmHg of this standard value. With females, the average is lower than the standard value by 5-10 mmHg. Blood pressure rises

approximately 5 mmHg for about one hour after eating. It is also influenced by posture, higher in the ascending order; lying down, sitting and standing.

4.3 Evaluation of Response Records

As described above, response to a false answer is interpreted on the basis of baseline shift. Analysis of baseline shifts covers the degree of shift, changes in amplitude, response time, and latency. Methods of quantitative measurement are similar to those of photoelectric plethysmography. As to the analysis and interpretation of the peak of tension test (POT,) it is necessary to consider not only the response to the decisive question but also to the response pattern of the whole series of questions.

Pulse wave response are classified into eight basic patterns given in Figure 17. Responses I, II, and III appear most frequently.

[Key to Fig. 17: Response Patterns of Pulse Wave (Circle Indicates the Decisive Question)]

1. Pattern that responds only to the decisive question
2. Pattern accompanied by anticipatory response
3. Special pattern

Figures 18-25 are examples of the principal patterns of pulse wave response. All are recorded using POT.

[Key to Fig. 18: Example of pulse wave response using POT. The baseline rises following the presentation of the decisive question (3).]

[Key to Fig. 19: Example of pulse wave response using POT. The baseline falls following the presentation of the decisive question (3).]

[Key to Fig. 20: Example of pulse wave response using POT. The baseline rises and then falls with the decisive question (3).]

[Key to Fig. 21: Example of pulse wave response using POT. The baseline falls and then rises with the decisive question (3).]

[Key to Fig. 22: Example of pulse wave response using POT. The baseline rises gradually until the presentation of the decisive question (3) and then maintains the same level.]

[Key to Fig. 23: Example of pulse wave response using POT. The amplitude increases following the presentation of the decisive question (2).]

[Key to Fig. 24: Example of pulse wave response using POT. The baseline shifts following the presentation of the decisive question.]

[Key to Fig. 25: Example of pulse wave response using POT. The amplitude diminishes drastically with the presentation of the decisive question.]

II. Equipment

1. Outline

1.1 Terms

The equipment used for polygraphic testing is called the polygraph. The term polygraph refers to equipment that records many kinds of event and is in wide use in medical, physiological and psychological settings: It does not denote a lie detector.

Equipment of this kind is capable of recording a variety of physiological phenomena including brain waves, electromyograms, GSR, and respiration. Any equipment that records more than two of these kinds of responses at the same time and in parallel is called a polygraph.

Tracings recorded by a polygraph are called polygrams. The discipline or the technology (wider in scope than only lie detection technology,) is called polygraphy.

1.2 History of polygraphic equipment

In 1958 the Laboratory of Scientific Ivestigation [formal translation of the organization name not identified,] predecessor of today's National Research Institute of Police Science, imported a Keeler Polygraph model 302 from the United States. This machine stimulated domestic development of the TKK polypsychograph, KYS polypsychograph etc., to be applied to practical situations.

The TKK polypsychograph later evolved into the PR-4, TRP-1, and PCD-3 models. Beginning in 1972, KT-1 model polygraph began to be nationally distributed to prefectural police headquarters [including Tokyo-to, Kyoto-fu, and Hokkaido.]

1.3 Improvements of equipment

1.3.1 The improved TRP-1 model

Improvements to the TRP-1 model include

(1) Smaller and lighter versions

(2) Use of transistors in the amplifier

(3) Removal of bridge circuits

1.3.2 The improved KT-1 model

Improvements to the KT-1 model include

(1) Installation of a quick-break fuse to prevent the flow of excess electric current into a subject's hand

(2) Decrease of the electric current that flows to the hand; use of higher amplification to compensate for the resultant diminished response

(3) Change of input impedance of 1 M* [uppercase omega] to improve the accuracy of the GSR response

(4) Adjustment of the appropriate amount of electric current for the size of the electrode in use

(5) Use of constant current circuits

(6) Time constant of approximately 4 seconds

(7) Installation of calibration resistance switch for easier sensitivity checks

(8) Installation of an electromagnetic bulb in the brain wave recording device [EEG]

(9) Installation of an event marker

1.4 Components

Roughly speaking a polygraph consists of four components; Recorder, breathing measurement equipment, GSR measurement equipment, and pulse wave measurement equipment. The structure, methods of measurement, and methods of maintenance and inspection are described below, following actual practice centered around the model KT-1 polygraph. As to the mechanism of response manifestation and interpretation of data, please refer to Part I.

2. Individual parts and names

The KT-1 polygraph is shown in the photograph, Figure 26. In addition, a complete set includes a code to connect the machine to the electric source, a bag that houses other attachments, a pen case, ink, a laboratory dish, and electrode glue.

[Key to Fig. 26: Exterior of the KT-1 model polygraph]

Figure 27 indicates the machine panel and the name of each part. When not in use, four recording pens, electrodes for GSR, a breathing tube, and a power code are stored in a bag for attachments.

[Key to Fig. 27: Panel parts and their names

1. Roller and lever to advance the recording paper
2. Recorder
3. Lever for placing recording paper
4. Pen to record pulse
5. Pen to record GSR
6. Pen to record breathing
7. Marker pen
8. Knob to adjust position of pulse recording pen
9. Knob to adjust position of breathing recording pen
10. Calibration switch for GSR
11. Power outlet voltmeter
12. Mechanism to hold paper down
13. Paper speed control switch
14. Power switch

15. Recorder switch
16. Mechanism to hold paper down
17. Push button for marker
18. Sphygmomanometer
19. Instant switch [abbreviated as inst. switch: a stabilizing switch that protects recorders being damaged or amplifiers rendered inoperative due to electric shocks]
20. Vent valve switch
21. Knob to adjust position of GSR recording pen
22. Knob to adjust GSR sensitivity
23. Pen rest]

A pocket on the right side (facing the machine) stores a cuff and pressure application pump used for pulse measurement as attached to the machine itself. Figure 28 indicates positions and names for each part in the pocket.

[Key to Fig. 28: Position and name for each part on the right side of polygraph
a. Cuff for measuring pulse
b. Pump
c. Ground electrode
d. Breathing tube
e. Power fuse

Power connector, jacks for GSR, switches and fuses are placed on the

front wall of the machine. Figure 29 shows positions.

[Key to Fig. 29: Position and name for each part on the front side of polygraph

f. Electrode connector

g. Electrode change switch

h. Electrode insertion jack (1)

i. Electrode insertion jack (2)

j. Fuses for electrodes

k. Electrode plug

3. Record tracing parts

3.1 Placement of recording paper

Placing equipment on a desk, first see how much recording paper remains. When the paper change lever is pressed lightly, the paper storage bin lid jumps open by spring action. As indicated in Figure 30, the shaft goes through the center of the paper roll; the paper end goes through under the paper holder; the paper advancing lever is raised (push down toward up side) while paper goes through, then it is lowered.

[Key to Fig. 30: Placement of recording paper

1. Roller and lever to advance recording paper

2. Rubber roller

3. [illegible]

4. A roll of recording paper is firmly fitted to the groove as indicated by an arrow

3.2 Pen attachment

3.2.1 Inking

Ink is placed in the ink container attached at the other end of the pen. As indicated in Figure 31, press the ink container with thumb to draw ink from the tip of the pen; after ascertaining that ink flows well from the tip, firmly place it into the pen-receiver groove (the frog crotch; fork) in the main body of the machine. The pen with a small plummet is for the marker, the longest pen is for GSR, and the remaining two pens are for recording breathing and pulse respectively.

[Key to Fig. 31: Method of inking]

3.2.2 Hints for pen attachment

Ink should not be added after pens are attached to the machine itself for the following reasons:

(1) Ink that drips on the area under the pen attachment groove may cause malfunctioning.

(2) Pressure exerted on the attachment groove when ink is pushed to the tip of the pen may cause malfunctioning.

(3) Dripped ink soils the panel.

3.2.3 Cleansing of pens after use

After tests, pens are washed with water in the same way as when ink is added. If clogged, clean the tip of pens using a fine wire, supllied for the purpose, or immerse into hot water.

3.3 Power source

3.3.1 Inspection before switching power on

Before connecting the code to an alternating current of 100 V, make sure the knob for the adjustment of GSR sensitivity is at "0", and the power switch is at the "off" position.

3.3.2 Operation

After ascertaining the vibration of the voltimeter needle and the pilot lamp under the power switch to go on when the power switch is thrown on, the recorder is switched on. After this operation, paper begins to flow.

3.3.3 Points to check when paper does not flow

The following four points are to be checked if recording paper does not flow:

(1) Does electric current flow to the constant power source?

(2) Is the power source shorted or is the power line cut?

(3) Is the power fuse blown?

(4) Has the paper forwarding lever remained in the up position?

3.4 Inspection of the operation of the machine

Mechanisms that make paper flow at a set speed include: A synchronous motor that operates in the recorder, gears that change speed, a rubber roller, where paper is mounted to rotate, and a metal roller that presses down paper.

3.4.1 Inspection of paper feed speed

The paper's speed of advance can be at 2.5 mm/sec or 5.0 mm/sec. Usually tests are performed at a speed of 2.5 mm/sec. The faster speed, 5.0 mm/sec, is used when testing examinees with extremely fast pulse rate, for tests with certain time constants described below, and

for special studies, e.g., more detailed studies of pulse or breathing.

The standard criterion is a speed error range of + -* 2% [plus/minus 2%] when paper runs for 3 minutes respectively at speeds of 2.5 mm/sec and 5.0 mm/sec.

3.4.2 Inspection of the paperfeed roller

Unless the placement of a roll of paper is exact so that it parallels the main body of the machine, paper wrinkles will occur occasionally with the result of paper jams around the shaft roller. If the paper position stays in place after a few minutes, one can judge that it is appropriately placed. In the case of the TRP-1 model with upper and lower paper pressure rollers, the springs of these rollers must be kept in balance.

3.4.3 Inspection of uneven paperfeed

If a temporary stoppage of paper is observed, the points described below need to be checked. It is rare to suspect a defective motor.

(1) Oil stains on the paperfeed roller may be causing paper slippage.

(2) Resistance between the shaft at the center of the paper roll and the shaft support may be high, due to improper placement of paper

roll.

(3) The spring at the paper forwarding lever may be defective. If the lever is not lifted after tests, there is a danger of the rubber roller under the paper forwarding roller becoming distorted with the result that paper will not flow uniformly.

3.4.4 Marker

The marker is called also an event marker or check marker. When the button to activate the marker is pressed, an electromagnet causes the pen to vibrate a little. The marker is installed for the purpose of precisely recording the place where questions were asked, answers were given, or noises occurred.

4. Respiratory movement measurement equipment

4.1 Construction

The respiratory movement measurement equipment consists of a breathing tube, Figure 32, and a bellows stored inside the equipment itself. The mechanism that converts physiological changes of an organism (a subject) into electric resistance, electric voltage, electric current, or pneumatic pressure is called the transducer or sensor. Figure 32 presents a breathing tube, a type of sensor. At times this in itself is also called pneumograph, but more strictly speaking, it is the

respiratory movement recording equipment as a whole that defines a pneumograph.

[Key to Fig. 32: Breathing tube]

4.1.1 Breathing tube

The breathing tube is a rubber tube with horizontal pucker and is about 30 cm in length. Air fills the tube. One edge is sealed tight, while the other end leads to the bellows in the main body, through a joint connected to the rubber tube. The tube, attached to an examinee's chest or belly, expands with inhalation and contracts with exhalation. Along with this movement of contraction and expansion, changes in air pressure inside the tube are transmitted to the bellows.

4.1.2 Bellows

The bellows is made of phosphor bronze, shaped similarly to a small Odawara style lantern, and is elastic. When the tube contracts, the bellows expands; when the tube expands, the bellow contracts.

Expansions and contractions of the bellows are conveyed to a crank via a connecting rod, and are converted into semicircular movement at the pivot. A recording pen for breathing is placed over the fork on the pivot. The position of the pen on paper is adjusted by moving a knob

which transports the whole bellows back and fro via gears (cf. Fig. 33.)

[Key to Fig. 33: Respiratory movement measurement equipment (inside view of the main body)]

1. Crank
2. Bellows
3. Pivots
4. Frog crotch [fork]
5. Center[ing] screw
6. Knob for pen position adjustment
7. Connecting rod
8. To the tube

4.2 Attaching the breathing tube

Breathing tube is attached to an examinee's chest or abdominal region (cf. 2.2.4 in part I for details.)

4.3 Adjustment of wavelike tracings

Optimum amplitude for wavelike records is 15-25 mm. Changes in breathing waves are difficult to see in records with amplitude of less than 15 mm. In such a case, consideration should be paid to the following points:

(1) Have an examinee wear as little clothing as possible.

(2) Change the position of tube attachment.

(3) Tighten the tube a little.

(4) Insert an object such as a ruler perpendicular to the tube.

(5) Adjust the plummet attached to the pen to make the pen slightly lighter.

Figure 34 shows several examples of breathing curve records.

(1) is a proper record.

Pen balance is off in (2,) wherein the pen side is heavier so that the top of the curve appears somewhat flat.

The top part of the curve is missing in (3) due to loose fitting of the pen to the fork.

The breathing curve mixed with notches in (4) is due to subject's body movement; there is no mechanical defect.

An artifact due to slipped tube is shown in (5); this has nothing to do with emotion.

4.4 Performance check

4.4.1 Sensitivity check

Stretch the tube by 10 mm after it has been attached the tube to the main part of the machine and adjust the position of the breathing recording pen to be parallel to the recording paper. When the tube is stretched further by 5mm and the amplitude of the pen lies within a range of 20 ± 5mm satisfactory sensitivity has been obtained.

The first procedure, 10 mm stretch of the tube, simulates the stretch when the tube is attached to an examinee. The latter 5 mm stretch takes into consideration the stretch to be caused by the examinee's breathing movement; the pen swings upward as the tube stretches.

4.4.2 Air leak check

If for some reason there is an air leak in the breathing measurement equipment, designed to be air tight, the device will not function correctly.

To check air leaks, the tube is stretched by 15 mm from the normal state and left for 3 minutes after the pen is adjusted to the position parallel to paper. If the pen has remained within 3 mm of the original (parallel) position after the 3 minutes have elapsed conditions are satisfactory. Since air expands and compresses as a

function of atmospheric (room) temperature, checks on sensitivity and air leaks must be conducted under a controlled temperature.

4.4.3 Points to pay attention to in handling

The breathing measurement equipment poses fewer problems than the pulse measurement equipment. Air leaks are mostly due to such causes as defective joing packings that connect the tube to the main body. As stated above, the bellows is placed in the body. A sudden change in air pressure other than change in the examinee's breathing, for example dropping the tube to the floor, may cause the bellows to lose its elasticity. Also, if unnessary pressure is exerted on the frog crotch [fork,] the pivots, the centering screw, or the crank may be distorted, resulting in inaccurate recording (cf. Figure 33.) Care should be taken not to bend rubber products sharply when storing, for rubber tubes tend to crack.

5. GSR measurement equipment

5.1 Methods of measurement

5.1.1 Electric current method vs. electric potential method

Two methods exist for measurement of skin electric activity: The electric current method in which changes in resistance are measured after passing electric current to the skin from outside, and the

electric potential method in which no external electric current is applied.

5.1.2 Condenser circuit vs. bridge circuit

There are two methods in which electric current is passed into the skin; one that uses condenser circuits to measure the relative value of changes in skin resistance, and another that uses bridge circuits to measure the absolute value of change.

As the skin resistance changes constantly, its wavelike tracings take the form of ripples superposed upon a large undulating wave. This large undulating part is called the basic resistance or SRL (skin resistance level,) and the ripple-like transient change in the skin resistance are called galvanic skin resistance (GSR) or skin resistance response (SRR.)

Measurement of changes in SRL is made possible by using a bridge circuit simultaneously expressing GSR in terms of the unit of K* [Ohm; upper case Greek letter omega.] However, the TRP-1 and KT-1 models, measurement devices exclusively for GSR, employ condenser circuits, for such reasons as difficulties in handling, absence of large changes in SRL during the duration of one series of questions in a polygraph test, and the evaluation of records being based on the relative sizes of GSR within one question series which does not require expression in terms of absolute values.

5.2 Electrode

5.2.1 Types of electrode

Pure silver electrodes (purity of 99.95 %) and silver/silver chloride electrodes are used in polygraph tests.

Traditionally, only pure silver electrodes have been in use. The KT-1 model provides silver/silver chloride electrodes in addition. More accurate measurement is made possible by them since silver/silver chloride electrodes exhibit little polarization and little electric voltage is generated by the electrodes themselves.

5.2.2 Points to pay attention to in handling

Polishing of electrodes with a file before use should be avoided. If electrodes are washed with water well after use and are immersed in salt water before use, drifts generated from electrodes (unstable weak electric currents) can be eliminated. With a pure silver electrode, one side of an electrode blackens after use, since the electrode surface has turned into silver chloride.

Since round silver/silver chlorides electrodes have been given special treatment beforehand, polishing them is not desirable. When electrodes are filed, they generate noise that interferes with delicate measurements and distort tracings.

5.3. Electrode glue

5.3.1 Types of electrode glue

When recording EEG and EKG, it is common knowledge to use electric glue (an electrolyte); a polygraph test is no exception. As electrolyte, either NaCl (sodium chloride) or KCl (potasium chloride) are used.

5.3.2 Concentration of electric glue

The appropriate concentration for electric glue is the same as that of sweat, 0.05 mol.

5.4 Recording adjustments

5.4.1 Placement of electrodes

Electrodes are attached to the second and the fourth fingers of the hand on the side of arm that does not wear a measuring cuff. Fingers are liable to suffer from cuts or scratches. Even small injuries invisible to the eye may result in an unstable GSR, because the loss of resistance in the epidermis causes short-circuiting.

While GSR can be measured at palms, toes, and armpits, other sites that sweat under mental stress, conduction of GSR from fingers is

preferred for ease of attachment of electrodes and ease of observation by examiners.

5.4.2 Electrode attachment

Prior to attaching an electrode to an examinee, the relevant part of skin must be cleaned carefully by wiping with a cotton ball soaked in alcohol. Dirty spots, especially oily substances, hinder the flow of electric current.

5.4.3 Operation of the equipment

Electrode plugs are inserted into the jacks for electrodes beforehand. After switching on power, sensitivity level is gradually raised by turning the sensitivity adjustment knob. Due to individual differences in the size of the GSR, sensitivity cannot be preset. Adjustment is done while observing GSR amplitudes, making the examinee take a deep breath or do simple mental calculations.

Before starting a test, the pen is placed 1/3 of way above the bottom of the recording paper, since it swings upward when recording GSR.

5.4.4 Artifacts

(1) When electrodes are attached too tightly: If electrodes are affixed too tight, examinees feel pulse beats at the place. Figure

35 is a tracing of such a case that shows GSR overlapping with a pulse beat. This phenomenon appears to be due to a change in the amount of blood in a finger which results in a change in the area of contact between the skin and an electrode. In such a case, it is necessary to loosen the electrode a little on the finger where pulse beats are felt.

[Key to Fig. 35: Pulse beat overlapping with GSR]
[Key to Fig. 36: Artifacts that appear due to the way an electrode is attached]

(2) Other cases: A in Figure 36 shows the artifact that appears when the electrode is detached temporarily from the finger due to the electrode being too loosely affixed. B is the artifact when two electrodes have shorted.

GSR is expressed as an upward swing on recording paper; it never appears as a downward swing as in B. These artifacts can be easily distinguished from the GSR from their extremely pointed waveforms.

5.5 Constant current compensating circuit

5.5.1 Basic principle

Figure 37 indicates the block diagram of KT-1 model GSR measurement equipment. When electric current passes through resistor, electric

potentials appear between the ends of the resistor; the value of the electric potential is propotional to the magnitude of the electric current (voltage = electric current x resistance.) This relationship holds as long as the value of the resistor is not altered by the current flow. In GSR measurement, the skin is considered to act as a type of resistor. However, the skin resistance is influenced by the electric current when current exceeds a certain level. Therefore, when applying electric current to the skin, the current intensity needs to remain within a range where the proportional relationship between voltage and electric current is preserved.

[Key to Fig. 37: Block diagram of GSR measurement equipment

1. Input
2. Constant current circuit
3. Balanced amplifier
4. Pen galvanometer
5. Power source]

5.5.2 Electric current density of electrode

Skin resistance can be considered as consisting of many resistors connected parallel. The number of resistors is determined by the skin area under the electrode. If a standard current flows into the skin, the intensity of the current is in inversely proportional to the number of resistors, i.e., the area under the electrode. Therefore, it is necessary to use a current intensity that allows the skin,

depending on the area under the electrode, to maintain the linear relationship of voltage/current.

For the relationship between the electric current that flow into the skin and the voltage at both ends to remain proportional, a current density of between 8μA and 11μA is thought to be optimal.

5.5.3 Galvanic current

SRL measured on human palms show individual differences ranging from several KΩ to several hundred KΩ, at times even as high as 1MΩ. Moreover, SRL fluctuates even during the time of measurement. Taking this fact into consideration, the constant current compensatory circuit of the KT-1 model is designed to stay within the range of 21-25μA regardless of the individual subject's SRL.

Since electrodes, attached to the equipment, are made of silver plate measuring 3.3cm^2, this specification practically satisfies the aforementioned electric current density of 8-11μA per 1cm^2.

5.6 Time constants

As stated before, changes in skin resistance consists of a large undulation and small ripple-like components. A condenser circuit contains a differential circuit that serves to eliminate this undulation. This differential circuit is a type of bypass filter

which passes only the high frequency component, while not letting through the low frequency component; the circuit is given in Figure 38.

[Key to Fig. 38: Differential circuit

1. Input
2. Output]

5.6.2 Calculation of time constant

Time constant is defined as the product of the capacity of the condenser and resistance in the differencial circuit (C x R = T.C.) For example, if the capacity of this condenser is 1μF and the resistance, 100 K Ω a time constant of 0.1 second is obtained.

$$\begin{aligned} \text{T.C.} &= 1\ \mu\text{F} \times 100\ \text{K}\Omega \\ &= 10^{-6}\ \text{F} \times 105\ \text{K}\Omega \\ &= 10^{-1} \\ &= 0.1\ \text{(second)} \end{aligned}$$

The larger the time constant, the more easily the low frequency component filters through.

5.6.3 Time constants for the KT-1 and TRP-1 models

Time constant for the TRP-1 model is 2 seconds $\pm$ 0.5 second and that for the KT-1, 4 seconds (permissible error range $\pm$10%). The reason

for this change comes from the fact that, while a short time constant is suitable for recording high frequency phenomena (the upper limit of high frequency component for EEG is approximately 30 cycles with 0.3 second time constant commonly used for recording), use of a long time constant that allows faithful recording of the original waveform is better suited for a low frequency phenomenon such as GSR. However, if the time constant is made indefinite [* mathematical sign for indefinite used here,] the undulation is recorded, with ensuing complications in the operation of the machinery.

5.6.4 Checking time constant

Figure 39 shows records of the same phenomenon with varying time constants in four channels with the same sensitivity.

[Fig. 39: Different waveforms depending on the time constant
1. 1 notch = 1 second]

When time constant check is made from the recorded waveform, record waveforms using the identical procedure as the check for sensitivity. Then measure the time needed for the amplitude of a change in resistance, 100 %, until it is reduced to 63%, starting the count from the time when the wave has begun to rise. With the KT-1 model, a resistance of 30KΩ is loaded to the input when the electrode is taken out of the jack; when the calibration switch is pushed upward, a further resistance of 1KΩ is loaded, allowing for checks of

sensitivity and time constant.

5.7 Input impedance

5.7.1 Basic concepts

An amplifier with time constant, such as described above, is called a CR [Capacitance-Resistance] coupling amplifier or resistance-capacitance coupling amplifier. When an electric current is input into an amplifier, the input impedance of the amplifier and the output impedance of [the coil] that sends out the current must match. Otherwise, changes in the phenomenon being measured cannot be accurately amplified.

As indicated in Figure 40, the relation between the resistance of a finger or a palm in the GSR measurement and the input impedance of CR coupling amplifier is analogous to resistors connected in parralel. The voltage of the current that flows into the amplifier diminishes unless R_2 is sufficiently larger than R_1, where R_1 is the skin resistance and R_2 is the input impedance of the amplifier (while R_2 in the Figure 40 actually is installed within the amplifier, for the sake of convenience it is depicted as placed outside.) In such a case, therefore, only a slight response is visible on recording paper, even though the skin resistance has changed.

[Key to Figure 40: Relationship between input impedance and skin

resistance

1. Skin resistance
2. CR coupling amplifier
3. Input impedance]

5.7.2 Input impedance of KT-1 model and TRP-1 model

As described above, individual differences in the base resistance are rather great. Besides, base resistance changes moment by moment in the same individual. Therefore, unless R_2 is sufficiently large, depending on the individual there may be cases in which change in GSR is not recorded. Or, even with the same individual, the apparent GSR is recorded on paper in a reduced size due to a change in the base resistance. For of this reason, the input impedance of the KT-1 model was improved to 1MΩ from that of 50KΩ of the KT-1 model.

5.8 Performance check

The following is a procedure for testing GSR measuremnt equipment.

(1) Connect the 500KΩ resistor to the input terminal.
(2) Maximize the equipment's sensitivity.
(3) Reduce the input resistance connected in (1) by 1KΩ.

If the pen swings more than 5 mm in response to the change of input resistance described above, the machine meets the standard. As to the

performance check for time constant, refer to 5.6.4.

6. Pulsewave measurement equipment

6.1 Construction

6.1.1 Measurement system

Similarly to the breathing measurement equipment, a pneumatic system (conversion of changes in air pressure into mechanical changes) is adopted for the pulsewave measurement system.

6.1.2 Composition

The device consists of a cuff attached to an examinee's arm, a pump, a manometer, a bellows, a pen, rubber tubes, cocks, etc.

6.1.3 Principle of operation

When an appropriate air pressure is applied to the cuff worn around an examinee's arm, the change in the volume of blood in the arm is converted into a pneumatic change. This change in the air pressure is transmitted to the bellows installed inside the main body of the machine via a fine rubber tube. The bellows, enclosed in a metal cylinder, is of a finer construction and is more sensitive than the one for the respiration measurement equipment. As indicated in Figure

41, air pressure changes, transmitted to the bellows via the back-and-fro movement of a connecting rod and semicircle movement of a pivot, reach a pen attached above a pivot.

[Key to Fig. 41: Pulsewave measurement equipment (inside the main body)

1. Center screw
2. Crank
3. Pivot
4. Center screw
5. Center screw
6. Pivot
7. Crank
8. Center screw
9. Connecting rod
10. Bellows
11. To the cuff
12. Knob to adjust pen position

As to the knob for adjusting pen position; when the whole body of the bellows is moved back and front, the connecting rod moves the same way.

6.2 Attaching the cuff

6.2.1 Wrapping the cuff around an arm

In polygraph testing, pulsewaves are conducted from the upper arm. When wrapping the cuff, the upper arm should be covered with as little clothing as possible. Otherwise, pulsewave changes would be absorbed in clothing so that satisfactory records cannot be obtained. Caution should be taken, for the part of an underwear, tucked upwards around the shoulder, can sometimes be too tight so that the blood flow to the arm is hindered; that results in inadequate recording.

It is easier to wrap the cuff around the upper arm with no air inside. The rubber tube that extends from the cuff rests on the inner side of the arm.

6.2.2 Position of the arm

If the cuffed arm moves during a test, artifacts may mix with recordings. Also, if the arm is lowered, the blood pressure rises. In order to obtain adequate recording in such a case, the air pressure in the tube may have to be raised. To avoid these complications, the examinee's arm is to be placed horizontally, making use of an armchair or a desk. In this way, unconscious movements of the examinee's arm can be observed and the cause of the artifacts can be detected early.

6.3 Adjustment of waveform

6.3.1 Operation and Pressure

After attaching the cuff, air is sent into the cuff while watching the movement of the manometer needle. The pressure should once reach a level of 100 mmHg, then one should gradually decrease the amount of air. While observing movements of the manometer needle, the pulse is measured at its maximum value.

Please refer to 2.4 for the relationship between the level of air pressure and the waveform. While measurement practice in the United States calls for an averge pressure of 100 mmHg, in Japan a pressure of no higher than 90 mmHg is used, even if recordings are somewhat unsatisfactory.

6.3.2 Examples of response measurement

Figure 42(A) shows an adequate waveform; a dicrotic rise is situated approximately in the middle of the amplitude. Figure 42(B) records artifacts caused by examinee's arm movement. Abrupt changes such as this do not accur from any other causes than examinee's movement, so that it is easy to distinguish them from pulsewave changes caused by emotion. Figure 42(C) is recorded with the same examinee as in 42(A) and 42(B) under the identical conditions concerning the attachment of cuff and pressurising. The only factor different is the balance of the pen. The amplitude and waveform are distorted in (C) as the result of adding slightly more weight on the pen in comparison to (A) and (B.) When measuring a pulsewave, the balance of the pen must be checked more rigorously, for volumetric changes in an arm are fainter

in comparison with recording either respiratory waves or GSR.

6.4 Performance check

6.4.1 Sensitivity check

Pulsewave measurement equipment is checked following the procedure below.

(1) Wrap the cuff around a hard object (for example, a round tea canister [made of metal; a common object found in Japanese households.])

(2) Raise the pressure to 80 mmHg.

(3) Using the knob for the adjustment of pen position, adjust the pen to parallel the paper.

(4) Press the cuff in a way so that the manometer records a 2 mmHg rise in pressure.

If the pen swings more than 10 mm, the condition is met satisfactorily.

6.4.2 Air leak check

While the same principle governs both the pulsewave and the breathing

measurement equipments air leaks may occur with the former. Since a pump supplies air externally, the air within the pneumatic equipment is compressed to cause occasional air leaks.

In checking air leaks, wrap the cuff around a hard object as in checking sensitivity, and raise the pressure to 90 mmHg. After 10 minutes, adjust the pen parallel to paper. If the swing of pen is under 5 mm after another 10 minutes, it is deemed tolerable.

6.4.3 Locating the site of an air leak

When an air leak is suspected, bend hard rubber tubes that stick out from the main body of the equipment (tubes connected to the cuff and the pump) one by one to see if the air leak stops. If the air leak ceases when the rubber tube leading to the cuff is bent, a pinhole in that tube is discovered. Usually such pinholes are quite small that it is difficult to locate them, even when an inflated cuff is immersed into water.

If the site of an air leak cannot be located after this procedure, apply soapy water to the connection of the bellows and the rubber tube or of the valve and the tube and see if air bubbles form.

6.4.4 Points to pay attention to in handling

Many parts of the pulsewave measurement equipment are made of rubber

as with the breathing measurement equipment. Bending these parts hard when storing the machine may cause cracks that result in air leaks. If exposed to a sudden and strong pressure, the bellows sometimes loses elasticity. A shock to the frog crotch [fork] may damage the pivot or center screws.

III. TEST PROCEDURES

Part III deals with procedures ranging from requests for tests, actual testing, and reporting of test results to the receipt of test records. A polygraph test follows a set procedure. Satisfactory test results cannot be expected if a part of the procedure is skipped, or if the test procedure is reversed.

1. Pretest preparation

Pretest preparation includes the entire work that begins with the receipt of a request for testing to the point that immediately precedes an interview. The main work includes consultation with the investigator in charge, collection of material for questions, preparation of questionnaires, and checking of equipment.

1.1 Pretest procedure

1.1.1 Acceptance of a test commission

(1) Upon receipt of a test request, an in-depth consultation with the

investigator in charge is indicated to confirm whether the contents of the case as well as the person of the examinee himself/herself appropriately meet the conditions for a polygraph test. Only then is a test commission accepted.

(2) A necessary condition for a polygraph test is that the examinee is in such mental and physical condition that he/she can understand the contents of questions completely and display the physiological responses that correspond to the question. Therefore, persons with conditions listed below are deemed inappropriate for a polygraph test.

(a) Those with high or low blood pressure (with the exception of those diagnosed by physicians to be fit for the test)

(b) Those with mental disorders

(c) Those with mental deficiency

(d) Those diagnosed to be so neurotic as to be in quite an unstable emotional state

(e) Those who are pregnant

(3) When materials suitable for use in developing peak of tention test (POT) and control question test (CQT) cannot be obtained, effective testing is not feasible. Therefore, the examiner should

find out from the investigator in charge as many details as possible about the contents of the case and the progress of the investigation to make sure that sufficient materials for questionnaire development can be collected.

1.1.2 Date and place of test

(1) It is desirable to do testing as soon as possible after the test commission has been accepted. A date is picked with consideration to allow enough time for pretest preparation.

(2) The test is be performed in a room devoted to this purpose. If a test must be given in a room not exclusively for this purpose, inquire about the condition of the room and request to have the items below satisfied as much as possible.

(a) No outside noise should be audible.

(b) No third party should enter the room.

(c) Nothing should be visible from windows that may distract the subject.

(d) No telephone should be present in the room. If there is a telephone, request the section in charge to disconnect it during the test.

(e) There should be little traffic in the corridor outside the room. This problem can be solved to some extent posting a sign in the corridor that says: "Test in progress; please be quiet."

(f) Put the room in a good order.

(g) Appropriate illumination (approximately 50-100 lux) and temperature (20-25 degrees Celsius) should be maintained.

(h) If the examinee is under detention, incidents such as an examinee's escape should be prevented.

1.1.3 Consent documents for the test

(1) Polygraph test should be given only to those who have consented to it.

(2) After agreeing to do the test, the examiner should ascertain at the time of the consultation with the investigator in charge that the examinee scheduled for a test has clearly indicated his/her willingness to be tested.

(3) The examiner requests the investigator to prepare a document of consent signed by the examinee.

(4) After explaining the function of the equipment, as well as test

procedures, the examiner confirms the examinee's voluntary consent by presenting him/her with the document of consent, or by reading aloud contents of the document.

1.1.4 Observer

(1) If the examinee is a woman, the presence of a female observer is desirable. Make a request to obtain the collaboration of an adult female staff member.

(2) The position of the observer during the test is important. If the observer is close to the subject, the examinee's attention may be concentrated on the observer. Therefore, the observer should be placed as far away possible, out of the examinee's field of vision.

(3) The examiner requests the observer not to make any noise that may interfere with the test.

1.2 Collecting material for questionnaire development

1.2.1 Sources of material

(1) The main sources of material for the preparation of POT and CQT include: case records (notice of damage, investigative report, and depositions,) onsite photographs, explanations provided by the investigator, testimony of the victim, and records of observations

about the scene of the crime.

(2) In order to grasp the outline of the crime, such documents as notice of damage, depositions, and onsite photographs need to be studied first. Material for preparing important questions also can be extracted from these documents.

(3) When consulting with the investigator in charge, obtain information as to the progress of investigation, along with authenticating facts in such material as a deposition. Information from the investigator in charge often contains important facts that can be used as suitable material for questions. When necessary, information from the deposition should be confirmed as well.

(4) If an interview with the examinee can be arranged to gain detailed information on the facts of the damage, important material for question development may emerge.

(5) Observe the scene of the crime. Because the observation is done from the viewpoint of a polygrapher, this will be an opportunity to obtain material different in character from indirect materials such as documents, photographs, or information obtained via the investigator.

(6) Survey the extent of knowledge the general public possesses about the case from such mass media as newspapers, magazines, radio and television broadcasts, or through neighbors' rumors.

1.3 Test preparation

1.3.1 Questionnaire development and equipment checks

Preparations required prior to entering the test room to administer a test consist of the development of questions and the checking of equipment. Details for development of the questionnaire and equipment checks are found in Chapter IV and Chapter II, respectively.

1.3.2 Checking the test room

(1) Prior to the actual test, put the test room in order and ascertain whether the conditions described in 1.1.2 are satisfied.

(2) Determine where to place the examinee's chair. Sit on the chair to see if any distracting object comes into view. If so, remove it or change the position of the chair.

(3) Pay attention to ventilation and room temperature, bearing in mind seasonal variability.

2. Interview prior to questioning

Prior to the presentation of questions to the examinee or the recording and measurement of corresponding physiological responses in

terms of three indicators, an interview is conducted. This interview is a necessary condition for effectively conducting a polygraph test and drawing clear conclusions from it.

2.1 Introduction to testing

2.1.1 Establishment of a psychological bond

(1) A psychological bond is established through a discussion between the examiner and the examinee, in which both clearly define their own positions.

(2) If the examinee has nothing to do with the crime in question, he/she will cooperate positively and follow the examiner's directions to bring about good test records.

(3) Even when the examinee has actually committed the crime and is hiding it, if he/she takes a surface attitude of cooperation in the interview, the test will progress smoothly.

2.1.2 Explaining the examiner's position

(1) The purpose of the interview is, in the first place, to reduce examinee anxiety and tension and to familiarize him or her with the testing environment.

(2) Another purpose is to have the examinee understand the examiner's role and test procedure. First, explain that the examiner plays a different role from that of an investigator. In particular, explain that the examiner takes an objective point of view as much as possible, and is not swayed by preconceived ideas or prejudice, that he endeavors to conduct a fair test, using equipment, called the polygraph, in order to discover the truth in cooperation with the examinee.

2.1.3 Acceptance of the examinee's assertions

(1) Most examinees will make such assertions as "I am not connected with the crime; it is a nuisance to have become a suspect." The examiner should display an attitude of acceptance toward such assertions from the examinee. The examiner answers, for example: "It certainly may be as you say, but it is difficult to prove. The polygraph test can provide the grounds for deciding that you are speaking the truth. So long as you are telling the truth, there is nothing to worry about. Please cooperate with the test."

(2) When the examinee indicates that he/she wants to explain his/her stand, try to listen. Some examinees, however, attempt to talk at length about unrelated matters. In such cases, in an appropriate way have the examinee discontinue and proceed with a smooth interview, displaying an attitude of understanding.

2.2 Observation of the examinee and record taking

2.2.1 Records

(1) During an interview, the content of the examinee's statements, expressions and bodily movements need to be recorded in as much detail as possible. Although the examiner may pose questions to confirm contents of the examinee's statements, emotional refutations or accusations must be absolutely avoided.

(2) When making records, do not remain in the examinee's sight. Moreover, records need not be taken verbatim. The best way is to take coded records. The examiner conceptualizes information obtained from the examinee (including statements, expressions, and body movements) beforehand and establishes codes to describe them. In the course of the interview, it is desirable for the examiner to record the content of the information using these codes.

2.2.2 Accepting assertions

Record taking involves an attitudinal acceptance of the examinee's stands and assertions. Expressing an attitude that the examiner is listening to the examinees' stories in earnest, and is ready to accept their assertions, is important in establishing a psychological bond with examinees. Examinees who are speaking truthfully will thereby gain a favorable impression of the examiner and will come to trust the

examiner's attitude.

2.2.3 Pointing out contradictions

Sometimes examinees' attitudes may change during presentation of questions. They may become uncooperative or attempt to intentionally confuse the record of their responses. If this occurs, change the unfavorable attitude of the examinee by pointing out discrepancies or contradictions in their assertions based on the record.

2.3 Examinee attitude

2.3.1 Nervous attitudes

(1) The most common characteristic examinees display is a nervous attitude, betrayed by nervous tone of speech or movements. This attitude generally settles down when test procedures are explained in the interview.

(2) Some examinees express the fear that, since they are timid or nervous, examiners may reach erroneous conclusions. In such a case, the examiner should explain fully that "timidity or nervousness" is not a contributing factor in making erroneous decisions. Examinees usually are satisfied with this explanation and do not return to this problem. However, if there is one who repeats this point, measure and record their breathing or GSR, placing them in a comfortable position

with their eyes closed. As long as the examinee does not intentionally attempt to disturb his/her responses, within 5-10 minutes the pattern of breathing waves will become uniform and the occurrence of autogenic GSRs will decrease. While there is no need to show this recording to the examinee, examinees for the most part are satisfied when the examiner explains in a confident manner that the examinee has returned to a state of composure.

2.3.2 Anger

(1) Some examinees display Anger. No matter what the real reason may be, examinees give the impression that they feel that it is unpleasant to have been made to take the examination and that they are very angered by it. However, when the interview test procedures are explained, such examinees for the most part understand and their anger quiets down.

(2) When the examiner chooses the right card chosen by the examinee in a card test demonstration, innocent examinees' tension will ease and feelings of anger will disappear.

(3) Among those examinees who hide their links to the crime, some take a bluffing attitude and continue to display anger. In such a case, it is essential that the examiner remain cool. For example, make the examinee understand by pointing out that the examinee has consented to take the test and to be cooperative in order to prove

that he/she has nothing to do with the crime.

2.3.3 Curiosity about the equipment

Some examinees show curiosity about the test equipment. They may pose such questions as: "Will I get electric shocks? or "How are the records taken?" Politely explain the equipment to such an examinee. However, no detailed explanations are necessary.

2.4 Introduction to questionnaire

2.4.1 Choosing the POT questionnaire

(1) Adequacy/inadequacy of the contents of the POT questionnaire prepared beforehand is reconfirmed during the course of this interview.

(2) Confirm the extent of knowledge the examinee has about the crime that is the test's target.

(3) Have the examinee talk about his/her knowledge of the contents of the crime. The examiner speaks little, because importance is placed here in having the examinee explain. However, it is necessary to reconfirm the examinee's knowledge concerning the contents of questions adopted in the POT questionnaire, by asking, e.g., "Do you know how much money was stolen?"

(4) Some examinees insist "I don't know," because of a misunderstanding to the effect that "I may be mistaken for the criminal," even if he/she knows details of the crime. Therefore, it is necessary to add, e.g., "Even if you have no direct knowledge of the crime, tell me what you have heard from investigators or know from newspapers or TV."

2.4.2 Introduction to CQT

(1) Reconfirm examinees' knowledge and through their explanations the extent of their links with the crime. Based on the results, final decisions are made as to the content of the relevant questions.

(2) With the intent to direct the examinee's attention toward questions about a hypothetical crime, explain the "content of the crime" scheduled to be used for the hypothetical crime questions. Emphasize the similarity between the hypothetical crime and the crime on which the relevant questions are based. Explain that a high probability exists that the criminal in the crime under investigation is as well the criminal in the hypothetical crime.

(3) Control questions must be set up, with contents to which examinees would certainly answer no.

2.4.3 Notification of questionnaires

(1) Before recording physiological responses, the examinee must be informed of the content of the POT and CQT questionnaires.

(a) Ascertain if the examinee fully understands the content of the questions.

(b) Ascertain if the examinee understands how to answer each of the CQT questions.

(c) Eliminate the examinee's worry that questions irrelevant to the crime in question may be asked.

(d) Read the contents of each list in the questionnaire to the examinee before actual presentation. If necessary, explain these. Also notify the examinee that no questions other than the ones that have been read to him/her will be asked.

3. Adjustment of measurement equipment

Adjust the measurement equipment with the objective of acquiring the best records to make clear decisions. When making adjustments, the examinee's suggestions need to be listened to. If the electrodes attached to the examinee gave him/her an unpleasant feeling, this unpleasant feeling elicits physiological responses. Confused records resulting from this will make decision making difficult.

3.1 Adjustment after the start of question presentation

3.1.1 Points to pay attention to when measuring pulse

(1) Examinee's complaint that the pressure from the cuff is unpleasant, often stems from tension felt in the testing situation. Therefore, explain test procedures fully and try to relax the examinee's tenseness.

(2) Aside from those examinees who intentionally complain of feelings of pressure in an exaggerated way, examinees' understanding can generally be gained if the explanation is given to the effect that the cuff will frequently be deflated so as to shorten the time it is to be inflated.

(3) Despite examiner's explanations and the effort at shortening the time of pressurizing, some examinees exaggeratedly insist on the unplesantness of the cuff pressure, expecting the effects described below.

(a) The examiner might misunderstand that "this examinee is oversensitive" and think it impossible to continue testing. The examinee expects, as a result, that the examiner, based on his/her own judgment and without waiting for the examinee's request, "Please discontinue the test," may discontinue the test.

(b) The examinee, with the excuse that "because of a strongly unpleasant feeling, he/she can't help moving," tries to move, contrary to the examiner's directions. The examinee expects that intentional body movement will elicit confused physiological responses, which may mislead the examiner.

3.1.2 Intentional interference

(1) Some examinees, especially those who are hiding their crimes, intentionally try to cause confusion by distorting their responses. Moving feet or changing the breathing rate are examples of examinees' tricks that are employed for this purpose.

(2) In coping with such interference, the examiner points out the examinee's activities and explains that confusion in the record is disadvantageous to him/her.

4. Presentation of questions and recording of responses

After adjustment of the machine is completed, measurement of the three indicators of physiological response, breathing, GSR, and pulse begins. Presentation of questions consists of a preliminary test (the card test), and CQT and POT that relate to the crime, the object of the testing.

4.1 Card test

4.1.1 Significance

(1) This test is given to make the examinee understand the relation between the presentation of a question and the answer to it.

(2) Some of examinees who are hiding their crime attempt to intentionally confuse their responses to the card test. The purpose of this interference is to elicit responses that do not correspond to the question, thereby making the examiner make an error in decision making. The examinee expects that the examiner will think that "this examinee's physiological responses are quite irregular so that the person is unsuitable for a polygraph test." However, the examiner can detect the intention to interfere through the observation of response records. At this point, the examiner warns the examinee to stop the interference.

4.1.2 Position

(1) The card test is given immediately prior to the presentation of CQT and POT question lists.

(2) The card test also may be given at the beginning of question presentation, between the first and second presentations.

4.1.3 The effect of the card test given before presentation of questions relevant to the crime

(1) The test has the effect of eliminating groundless anxieties about polygraph tests. It helps to make the examinee understand that no physical and psychological pain accompanies the test procedures.

(2) It helps the examinee understand the basic procedures of a polygraph test, thereby smoothing later presentations of the questions.

(3) It makes the examinee understand the accuracy of the polygraph equipment. It alleviates the anxiety of examinees who are telling the truth and, on the other hand, makes those who are hiding their crime recognize the effectiveness of the test.

(4) It helps persuade those who express feelings of dissatisfaction or anger against taking the test. By the examiner successfully picking the card chosen by examinees, they become convinced that the test is effective in clearing up the suspicions cast on them.

4.1.4 The effect of the card test given in between CQTs

(1) As a result of the card test, examinees hiding their crime who may have managed to display almost no response in the first round of questions, will begin to respond rather remarkably after the second round of CQT, when they have recognized the effectiveness of polygraph tests.

(2) Examinees who are hiding their crime and may have at first attempted during the first presentation of the CQT to intentionally interfere, will as a result of the card test find that their efforts have been futile. Therefore, after the second round, they abandon the effort to intentionally control their response to relevant as well as to control questions.

(3) As a result of the card test, examinees who have no connection to the crime gain more confidence in the effectiveness of the polygraph test and their responses to control questions become rather more prominent.

(4) Some examinees who are stating the truth display generally confused responses at the first presentation of the CQT because of their prominent tendency toward nervousness. As a result of the card test, they come to recognize the effectiveness of polygraph tests, displaying responses only to control questions and the general confusion disappears.

4.2 Questions relating to the crime

4.2.1 The number of questionnaires and time

The number of questionnaires to be presented to the examinee is decided by the type of the crime to be investigated, and the quality and quantity of the materials collected for test development.

However, the standard length of time between when examinees enter and leave the test room is approximately two hours, taking into consideration fatigue and other factors on the part of both examinees and examiners. Because the entire process, interview and the presentation of questions, must be completed during this period, the time for the presentation of questions naturally is limited. Even if abundant materials for developing questions were collected, items appropriate for POT and CQT are limited. Considering these conditions, the standard number of questions is determined to be the combination of one CQT questionnaire and 5-8 POT questionnaires.

4.2.2 Order of presentation

(1) One sample order of presentation is: Card test, CQT questionnaire, and POT questionnaire.

(2) One condition for correctly conducting a polygraph test is to have examinees' interest concentrate on the questions presented in order to obtain responses easy to make decisions about, whether they be positive or negative.

4.3 Writing codes for records

4.3.1 Codes

(1) When responses begin to be recorded, enter examinees' answers in

the recording paper in code.

(a) The code for the beginning of presentation is X; the end, XX.

(b) Numbers for a manometer record are expressed as, e.g. 80/A, written down at the beginning and end of each questionnaire.

(c) Examinees' positive answers may be coded as +, and negative, as -. Contents of answers can be noted concretely, e.g., + (yes), + (it is so), - (no), - (I don't know), etc.

(d) A diagonal line is drawn at the beginning and the end of question presentation to indicate the time for each.

(e) If the examiner has during the presentation adjusted the baseline for one of three indicators, write in an upward diagonal arrow or a downward diagonal arrow, depending on the direction of adjustment.

(2) When responses to external noises or telephone rings appear, or examinees' body movement interfered with recording, enter codes in English shown below, or write down the event specifically.

(a) M: Movement

(b) M ( ): Movement; enter the part of body moved in ( )

(c) C: Cough

(d) S: Sigh

(e) Sz: Sneeze

(f) N: Noise

(e) N ( ): Noise; enter the type of noise in ( )

5. Post questioning interview

Polygraph testing is concluded while maintaining the psychological bond between the examiner and the examinee.

5.1 End of measurement recording

5.1.1 Removal of electrodes and other attachments

Remove the breathing tube, manometer cuff, and GSR electrodes from examinee's body. Wipe paste off the examinee's finger tips with a cotton ball soaked in alcohol.

5.1.2 Signature on the recording paper

Detach the part that records test results from the polygraph equipment. Present the paper to the examinee and have him/her sign the test date and their name at the beginning and end of the paper.

5.2 Notification of results

5.2.1 Expression of thanks

While removing electrodes, etc., address the examinee saying, e.g. "Thanks for your trouble." This is to express thanks for the examinee's "cooperative attitude." At the same time, these gentle words and acts on the part of the examiner serve to draw further conversation from the examinee.

5.2.2 Questions from examinees

(1) Regardless of their involvement with the crime in question, examinees have a tendency to like to know the results indicated in the test records. Quite a few examinees ask outright. Even in such a case, there is no need to explain records in detail.

(2) Generally, answers such as that below will be appropriate to examinees' questions. "You are the person who knows best about the test results. If you have answered questions honestly, there is nothing to worry about. The results should indicate that."

(3) When examinees are not satisfied with the examiner's answers, the following explanation will do: "Record analysis takes a considerably long time. The investigator in charge will be informed of the results, so that if you have questions, talk with the investigator. Also, if you want to say something, tell him/her."

(4) Listen to what the examinee has felt. Ask the examinee to tell what he/she thought or felt at the time of and after the presentation

of questions.

IV. METHODS OF QUESTIONING

1. Introduction

Evaluation of a polygraph test is based on a chart of physiological changes that accompany questions posed to an examinee. Therefore, the questions asked are an important aspect of the test.

As stated in Section I, physiological responses may accompany false answers. Such changes do not indicate patterns or degrees of response that are specific to false answers. For example, breathing is suppressed while giving a false answer. However, such a change may accompany other emotions. Breathing may also be suppressed when a person is surprised. When we present the same question to several examinees who are all giving false answers we find that their responses are not necessarily the same. Individual differences exist in the level of peoples' responses, influenced as they are by factors such as their physiological condition, life histories, and differing attitudes toward the examiner.

Because of such individual differences in physiological response associated with false answers, decisions as to falsehood cannot be made solely on the basis of a particular response pattern or on the absolute value of a response. Methods of questioning that overcome

these difficulties are described below.

The basic principle behind these methods of questioning lies in comparing the examinee's physiological response to a question the answer to which the examiner already knows to be true or false with his/her response to the question to which the truth or falsely of the answer is problematic. Thus responses are compared within the same subject. Comparisons between different subjects' responses are meaningless.

Two methods of questioning exist.

(1) Peak of tension test (POT)

(2) Control question test (CQT)

2. POT

The POT consists of critical questions (or crucial questions) and noncritical questions (or noncrucial questions). This test aims at determining whether the examinee knows details of a crime that can be known only by the criminal, and tests whether examinees' statements about the matter are true or false. The basic principle is a comparison of responses to critical and noncritical questions.

The strengths and weaknesses of POT are as follows.

(1) Strengths

(a) In contrast to the CQT described below, questions can be constructed about small points at issue.

(b) The principle is a simple one.

(c) Tests can be performed by examiners who lack high grade interviewing skills.

(2) Weaknesses

(a) The POT presumes that a criminal will recognize and remember the point being asked about in a critical question.

(b) If details of the crime are public knowledge, tests employing this method are rendered almost impossible.

2.1 Composing of questions

2.1.1 Composing of questions based on an actual case

(1) Example

(a) Investigative situation being studied by the examiner

(i) Case: Suspicion of burglary.

(ii) Place and time: 2-6-21 Omotecho, Nishiku; at tobacconist Y (facing a main street with street lights) across the street from a post office; around 10 p.m.

(iii) Place of entry and exit: Unlocked kitchen entrance.

(iv) Victim: Store owner's wife M (33 years old,) alone eating an apple and watching TV in her pink pajamas.

(v) Damage:

(1) Money and goods stolen: Cash in the amount of 163,000 yen inserted between pages of a bank savings book in the drawer of the Buddhist altar (twelve 10,000 yen notes, eight 5,000 yen notes, and three 1,000 yen notes.) An emerald ring, also in drawer of the altar. Six cases of Seven Star [a brand of cigarettes] in a store locker.

(2) Acts against the victim: The burglar bound the victim's hands with a belt and her feet with the cord of a dryer.

(vi) Weapon: A large screwdriver in the assailant's possession.

(vii) Assailant characteristics as described by the victim: Age between 30 and 35; rather tall; wore work clothes, stocking mask, and a pair of knitted cotton gloves [work gloves].

(b) Information available to the public as surveyed by the examiner: Putting together TV and newspaper news, and neighbors' rumors, the following items were confirmed as public knowledge: Around 10 p.m. on A date of B month, a burglar broke into Y tobacco shop in Omotecho, Nishiku; he bound the owner's wife M's limbs, and stole cash of approximately 160,000 yen and several cases of cigarettes. The assailant appeared to be about 30 years old and his face was covered by stockings.

(2) Described below are examples of POT questions developed to address the hypothetical case described above:

(a) Example 1

The questions refer to what type of place it is in front of the burglarized tobacco shop.

1 Was there a gas station in front of the tobacco shop?

2 Was there a temple in front of the tobacco shop?

o 3 Was there a post office in front of the tobacco shop?

4 Was there a hospital in front of the tobacco shop?

5 Was there an elementary school in front of the tobacco shop?

6 Was there a fire station in front of the tobacco shop?

[o marks the critical question]

The example above is for an examinee who is thought to be "not familiar with the place."

(b) Example 2

The questions refer to the burglar's method of entry into the tobacco shop.

1 Did the burglar enter through the second floor window?
2 Did the burglar enter through the bathroom window?
3 Did the burglar enter through the toilet room window?
o 4 Did the burglar enter through the kitchen entrance?
5 Did the burglar enter through the glass door separating the corridor from the outside?
6 Did the burglar enter the shop from the side door?

(c) Example 3

The questions refer to where burglar stole the cash from.

1 From a dresser drawer.
2 From the portable safe.
o 3 From a drawer of the Buddhist altar.

4 From a drawer of the cupboard.

5 From the table top.

6 From between the bedding stored in a closet.

(d) Example 4

The question asks if the following items were to be found among the goods stolen.

1 Was a brooch stolen?

2 Were earrings stolen?

o 3 Was a ring stolen?

4 Was a necklace stolen?

5 Was a bracelet stolen?

(e) Example 5

These questions refer to what the burglar used to threaten the wife.

1 Was it a long Japanese sword?

2 Was is a mountaineering knife?

3 Was it a kitchen knife?

o 4 Was it a screwdriver?

5 Was it a dagger?

6 Was it a chisel?

7 Was it an ax?

(f) Example 6

This question refers to what the burglar used to tie up the wife.

1 Was it a towel?

2 Was it a wrapping cloth?

o 3 Was it a belt?

4 Was it a scarf?

5 Was it a necktie?

(3) Critical and noncritical question in the above examples

Among the questions above, those with "o" in front of them are critical questions; those without are noncritical questions.

2.1.2 Number of POT lists

Usually more than five POT lists are prepared.

2.1.3 Number of questions in each list

Each POT list consists of 5-7 questions including the critical question.

Responses to the first question (position responses) contain reactions to the transition from the prequestioning to the questioning phase. Therefore, comparing these with responses to critical questions is meaningless, responses to the first questions are to lay preparation. Because anticipatory or delayed responses sometimes occur immediately

before or after presentation of the critical question or coincidentally with the noncritical question that follows, at least five questions are needed for definitive decisions. However, the number of questions should not exceed seven at most, because too many questions prolong testing time and result in fatigue on the part of examinees or diminished responses that make decision making difficult.

2.1.4 Position and number of critical questions

(1) Position: The critical question is placed approximately in the middle of a series of noncritical questions for the reasons cited in 2.1.3.

(2) Number: Each list contains only one critical question.

2.2 Critical question

2.2.1 Significance of a critical question

The critical question is the question that is most important in eliciting a response from the examinee that will permit a decision as to whether he/she knows a detail about the case.

2.2.2 Basic conditions

(1) Critical questions are chosen from the totality of that part of

the information about the case that is not publicly known (cf. III-1.2.1 regarding methods of information gathering.) Therefore, the contents of these questions consist of facts known only to the investigating bureau, the criminal or the victim.

This basic condition must be observed so that the innocent are protected from misjudgement.

Therefore, in the example above, details such as "the time of the crime," "the tobacco shop," "cash of approximately 160,000 yen," and "masked by stockings," are inappropriate as critical questions.

(2) Even if some details have not leaked out, they should not function as critical questions if the criminal does not remember them. Checking to see if the criminal remembers what is asked in a critical question is a condition that must be observed so that the innocent be protected from misjudgments. It is the examiner's presumption whether a criminal remembers the contents of critical questions. Therefore, the examiner's judgments must be logical rather than dogmatic.

The following are general considerations to pay attention to as regards this basic condition.

(a) Intentional behavior is retained longer in memory than things that a person has seen or heard. Therefore, a question such as "Was the victim eating an apple?" is inappropriate as a critical

question in the examination above.

(b) Acts accompanied by emotion, fear, anger, joy, etc., make a strong impression and are retained long. In such a case, while the main acts are retained well, the details may not be. For example, while one may remember "beating" a person because of strong anger, "where" and "how many times" are not retained as well.

(c) Features concerning color are difficult to express as well as hard to remember. If an incident has taken place at night, color perception may differ depending on the level of illumination at the time of crime. In the example, it is better to adopt "what was worn" as a critical question or present the "thing itself," rather than ask about the "color of the pajamas the victim was wearing."

(d) If the criminal stole a wristwatch, he/she will naturally remember this fact. However, if the wristwatch was in a small box one must be cautious, because the criminal might not have opened the box after the crime. It is desirable to test making the "place where the wristwatch was found" the critical question; one fact needs to be confirmed from a variety of directions.

(e) If detailed facts concerning the crime have too many ramifications they tend not to be remembered. For example, place

of entry, types of stolen goods, or, as in the example cited above, "the tobacco shop in front of the post office" are remembered better than the number and quantity of stolen goods or the make up of the money stolen (e.g. how many 1,000 yen bills.)

(f) Memory is influenced by the examinee's level of intelligence or the time elapsed to recall as well as the object or the situation in question. Generally speaking, if a test is performed within 10 days of the crime, responses can be obtained that indicate that the examinee remembers the place of crime.

There is no set standard for the length of time memories may be retained. In a test two years after the crime, one examinee's responses were unclear; with another, prominent responses were obtained even after eight years. Therefore, testing is desirable at an early stage of investigation.

(g) Intentional behavior is easier to retain than random acts.

(3) Contents of critical questions must be based on accurate and objective information. Below are general conditions to be observed concerning this basic condition:

(a) Victims' statements occasionally may contain intentionally or unintentionally distorted facts. When victims have made erroneous statements because of their own misunderstanding,

surprisingly often they will not attempt to correct them later. Also, in quite a few cases, victims do not remember the exact amount of money stolen. Rather than relying solely on the victim's statements, it is necessary to obtain exact information through checking pass books or account books.

(b) In dealing with examinees suspected of repeated crimes of the same nature, critical questions must be prepared that can distinguish the particular case under investigation [from other similar cases].

(c) Matters concerning aesthetics, size, or quantity (relative quantity) of people and things are inherently subjective. Critical questions that touch on this type of topic are tantamount to asking for an examinee's subjective judgement. Therefore, there is a danger that such questions may lack the specific meaning to the criminal that is intended by the examiner for the question to serve as a critical one. Motives for the crime or murderous intent cannot serve as critical questions.

2.2.3 Form of the critical question

(1) With POT testing, examiners generally read questions to examinees. At times, however, maps, illustrations, or things left behind at the scene of crime may be presented during the course of testing.

(2) Incorporation of two critical items into one critical question should be avoided. One such example would be to ask as a critical question "do you know that after stealing the cash the criminal escaped from the open corridor?" If the criminal stole the cash but did not escape from the open corridor, confused responses may appear throughout the whole questioning, or, when the examinee is asked the critical question, a type of response may appear that makes evaluation difficult.

(3) The simpler the text is the better. The desirable quality in a question is that the examinee can understand it as soon as he/she hears it and can answer briefly with a "yes" or "no" without needing any further explanation.

If a question is difficult, the examinee's mental activity associated with the effort to understand will elicit responses; long answers may disturb respiratory responses. Question content that is easily understood by examinees is not only short, but also should conform to the an examinee's education, job, age, sex, or place of origin.

(4) When a critical question contains a word that has special meaning to the examinee, responses to that word itself may appear, even while truthful answers are being given. Attention must be paid to this point when asking about sexual matters, which are considered to be social taboos in a public place; religion; race; nationality; jobs; or abilities.

(5) When asking questions, different styles of speech may be used.

(a) As in the examples of (b) to (f) in (2), 2.1.1, each question is presented in a simplified form, since the outline of questions has been explained prior to the presentation of the questionnaire.

(b) "Did you steal ...?" (direct form; the subject of the sentence is the examinee)

(c) "Was ... stolen?" (direct form; the subject matter is the item stolen)

(d) "Did the criminal steal ...?" (direct form; the subject matter is the criminal)

(e) "Do you know ... was stolen?" (hearsay; the subject of the sentence is the examinee)

(f) "Do you know that ... was stolen?" (hearsay; the subject matter is the item stolen)

(g) "Do you know that the criminal stole ...?" (hearsay; the subject matter is the criminal)

2.3 Noncritical questions

2.3.1 Significance of noncritical questions

Both categories of examinees, those who recognize the contents of the critical questions in POT as well as those who do not, answer truthfully to noncritical questions. Responses to critical questions are compared with those to noncritical ones to draw conclusions as to whether examinees have or have not recognized the content of critical questions.

2.3.2 Basic conditions

(1) For each POT list four to six noncritical questions are prepared.

(2) Qualitatively speaking, noncritical questions are approximately the same as critical questions. For example, qualitatively similar questions about stolen items may be about such matters as their price, size, or use. Qualitative similarity will have been satisfied if noncritical and critical questions are presented side by side and the critical question cannot be distinguished. This basic condition must be met in order to avoid misjudging the innocent.

In the case of a stolen necklace, for instance, such items as a bracelet, ring, brooch, or earrings appear among the noncritical questions. These items can be considered of similar quality in the sense that they are all feminine accessories of a size easily placed in a palm.

If a soiled handkerchief was left at the scene of crime, a soiled handkerchief also must be presented during noncritical questioning.

(3) Even when qualitatively similar contents are chosen as noncritical questions, items inappropriate for the season, region, or the place should never be used. For example, in the case of a theft that took place in a women's dormitory use of men's personal effects in noncritical questions is best avoided.

(4) It is better to make noncritical and critical questions moderately dissimilar. If similarity of noncritical and critical questions is overemphasized, even the guilty, as well as the innocent of course, may find making distinctions difficult.

If a blackmailing letter was written with a red pencil, it is better to choose crayon, brush pen, pen, or felt-tipped pen for a noncritical question rather than a blue or green pencil. In the previous example (d) the items chosen in the example are more appropriate than adding "diamond" or "sapphire" in front of the word "ring." This basic condition must be respected to avoid misidentification of the criminal.

2.3.3 Form of noncritical questions

Items in 2.2.3 apply also to the form of noncritical questions.

2.4 Presentation of questions

Prior to testing, ascertain examinee consent to the test, select the examining room, make adjustments, and check the equipment. Testing begins with a preliminary interview, after the examinee enters the room and is seated in a chair. These test procedures will be discussed later. The following is the method of POT presentation:

2.4.1 Order of presentation of POT questionnaire items

Prior to POT testing the order of presentation for each questionnaire will be checked, keeping the following in mind:

(1) Ask early in the session about core matters related to the crime.

(2) Take into consideration the behavioral sequence at the time of crime.

(3) Arrange questions so that examinee cannot guess what the contents of the critical question will be in the next list from the contents of the previous list.

2.4.2 Final confirmation of the pertinence of the critical questions

As a final check prior to testing, confirm the pertinence of the contents of critical questions directly with the examinee. For

example, if a critical question contains the fact that the burglar entered from the kitchen entrance, ask "Do you know how the house was entered?" If the answers is negative, questioning continues with that list. If the answer is positive, ask further how the knowledge has been gained.

2.4.3 Notification of the order of question presentation

There are good points and bad points to notifying or not notifying examinees beforehand about the order of question presentation. Examiners decide which method to use depending on the situation they are in.

(1) An effect of surprise at the presentation of a critical question can be expected if the examinee is not notified and the examinee does not know when the critical question is to appear. However, in these circumstances, examinees' responsiveness is often enhanced so that unnecessary spontaneous responses may occur, thereby disturbing the whole record.

(2) With prenotification, relatively little unnecessary response disturbances appear. However examinees find it easy to interfere with testing, because they know where the critical question is.

(3) According to experimental studies, the rate of lie detection is higher with method (1).

2.4.4 Time interval between questions

Once testing begins, enter accurately on the recording paper the time when questioning began and ended, the questionnaire number, the question number, whether the answer is positive or negative, noting also external noises, and examinees' body movements, using appropriate codes (for details, see part III, item 4.3).

Appropriate time interval for starting the next question for each of three indicators is: For respiratory wave, 3 cycles or more; GSR, at the time when the response returns to the baseline; pulse wave, when the baseline begins to drop. Normal interval between questions, empirically established, is 12-30 seconds.

The basic condition of "similarity" described in the section on the types of noncritical questions (2.3.2), applies also to POT testing. Namely, within the same series, it is necessary to maintain constant the style and tone of speech as well as the question interval.

2.4.5 Repetitive presentations of the questionnaire

POT questionnaires are presented repeatedly. The same questionnaire usually is presented three times; in ascending order (question number 1-5,) in descending order (question number 5-1,) and at random.

If examinees move, it is better to make additional presentations.

Repetitive presentations make determinations easier by ascertaining that singular responses to a critical question are not accidental, eliminating responses that pose difficulties in decision making such as expectation or delayed responses, and habituating response disturbances caused by excessive tenseness.

When responses that occur immediately before or after a critical question are confused, decision making becomes easier by inserting a question to which examinee's responses have been weak immediately in front or after the critical question when presenting questions in a random series. If the same question list is presented to an examinee too many times, overall recorded responses become weak, thereby making evaluation difficult.

2.4.6 Eliminating monotony

When taking POT tests, examinees for the most part keep repeating negative answers, "No" or "I don't know." The testing procedure then tends to become monotonous. Some criminals may resort to deception and answer in the negative as soon as they hear a voice, without listening to what the question asks. To prevent such incidents, the measures listed below need to be considered to adapt to the situation.

(1) Ask the examinee's name at the beginning or the end of the question series to obtain an affirmative answer.

(2) Change the style of speech each time a new series starts.

(3) Provide a short rest period.

(4) Ask to recall questions.

(5) Hold a midtest interview.

Unless these measures are applied, the examinee's attention is not focused and the test cannot be expected to be effective.

2.5 Methods of decision making

2.5.1 Listening to the examinee's thinking

When testing is over, the examiner asks what the examinee has been thinking about during the test. The examinee's thoughts about individual questions often provide helpful clues when making decisions later. For example, if the examinee says that victim's name mentioned in a question happens to be the same as her own maiden name, her responses to the question must be evaluated taking this point into consideration. If the examinee's thoughts on a question happen to be illogical and dubious, that will further reinforce the evaluation reached by the examiner.

2.5.2 Examination of responses

(1) Response comparison and examination of patterns: Decisions are based on the comparison of responses to critical and noncritical questions. Responses to noncritical questions at the beginning of a question series may occasionally appear specific. As described earlier, decisions on such responses must be made taking into consideration the effect of the position response component.

When making decisions on POT tests, attention must be paid not only to responses to each question but also to the course that responses to a series of questions are taking as indicated by the name, "peak of tension." An example of such a case is the pulse wave baseline rising until the presentation of a critical question, then falling. The conclusion in this case should be that specific responses occurred in response to the critical question.

(2) Response consistency: There is no problem with the GSR when comparing responses to each question since this measure mostly concerns the magnitude of the amplitude. However, with breathing and pulse wave tracings care must be taken because different methods of analysis are available. With breathing waves, for example, amplitude may be suppressed in response to one question in a series while the breathing cycle may have changed in response to another. The problem here will be to decide which one of them is the more specific a response. Usually, the degree of change in the suppression of breathing wave amplitude or in the breathing cycle serves as a criterion for making a decision. If a decision cannot be made with

these criteria, the degree of responses to these same questions when they appear in another series will provide further reference points. Prominent responses may not necessarily and consistently accompany false answers in every question series. If consistent response changes to the critical question appear in every series, it can be assumed that the examinee has detailed knowledge of the case, even if these changes may not be the greatest ones in the series.

(3) Relations between response indicators: Individual examinees differ as to their response tendencies with each of the indicators. It is rather rare when giving a false answer to show specific responses on all three indicators. That is why so many indicators are measured in polygraph testing. While it is possible to make a decision when specific responses are observed only with one indicator this does not mean that other indicators need not be measured.

2.5.3 Categories of Evaluation

As described above, responses to critical questions are compared to those to noncritical questions. The result is classed in three categories depending on the degree of specificity.

(1) Specific responses are observed.

(2) No specific responses are observed.

(3) Presence or absence of specific responses cannot be ascertained.

2.6 Examples of response records

As stated before, one questionnaire is usually repeated three times. First, the degree of specificity of the responses to the critical question in each series is examined. Next, the questionnaire as a whole is examined with emphasis on response consistency between series of questions.

Listed below are explanations of records that show specific responses to critical questions. In each record, it was later confirmed that examinees recognized the critical questions as such.

(1) Example 1

The critical question in Figure 43 is number 2. While responses as a whole tend to be weak, suppression of the respiratory wave is observed following the presentation of the critical question. GSR occurs only in response to the critical question.

[Key to Fig. 43: POT response example]

(2) Example 2

The critical question in Figure 44 is number 4. No pulse wave responses are observed. While many spontaneous GSR responses are observed on the whole, the maximum amplitude occurs to the critical question. Breathing wave cycles becomes longer after the critical question; the baseline rises somewhat.

[Key to Fig. 44: POT response example
1. I don't know [handwritten note]]

(3) Example 3

The critical question in Figure 45 is number 3. In this example specific responses to the critical item are demonstrated in all three indicators: suppressed breathing, the maximum GSR amplitude, and the rising pulse wave baseline occur to the critical question. Small waves superposed on the respiratory curve usually appear when examinees are rather tense.

[Key to Fig. 45: POT response example
1. Test record for the third questionnaire (the first presentation) [handwritten note]]

(4) Example 4

The critical question in Figure 46 is number 2. Breathing wave amplitude increases in response to the noncritical question

immediately after the critical question. As seen in this case, response tendency may change immediately before or after the critical question. If the same tendency appears in the next series where another question is inserted between the second and the third question, this evaluation will be further supported. GSR amplitude reaches the maximum value at the critical question. No particular pulse wave response appears. At this level of pulse wave amplitude, the only useful indicator for decision making is a change in the baseline. Better results may have been obtained by sending more air to the cuff.

[Key to Fig. 46: POT response example]

1. No [handwritten note]]

(5) Example 5

The critical question in Figure 47 is number 2. Breathing as well as pulse wave recordings are appropriate, although no specific responses appear. GSR, however, is recorded up to the critical question, but it disappears thereafter.

[Key to Fig. 47: POT response example]

(6) Example 6

The critical question in Figure 48 is number 4. While breathing waves

are barely suppressed before the critical question, this is not considered to be specific. A GSR appears in response to the critical question. When examined against markings in the chart, the two GSRs to the left of these GSRs prove not to have occurred in response to questions. At the critical question, the pulse wave baseline rises abruptly, accompanied by diminished amplitude.

[Key to Fig. 48: POT response example

1. The 8th questionnaire, the 3rd presentation [in handwritten note]]

(7) Example 7

The critical question in Figure 49 is number 3. Respiratory cycles slow after the presentation of the critical question. A GSR occurs only in response to the critical question. No specific pulse wave responses are found.

[[Key to Fig. 49: POT response example

1. The 2nd questionnaire, the 2nd presentation [illegible].

(8) Example 8

Number 3 is the critical question in Figure 50. Respiratory cycles slow beginning with the first question. In response to the critical question the baseline of the respiratory wave shifts. After the

critical question, prominent GSRs appear in response to every question. While a slight rise in pulse wave baseline is recorded related to the critical question, it is so small that it cannot be considered specific. A sudden change appears in the pulse wave between question number 2 and number 1, marked with an arrow, indicating the place where the polygraph examiner has adjusted the equipment. If questions number 2 and number 4, to which no specific responses appear at all, are inserted before and after the critical question in the next series of questions, decision making becomes easier. This procedure can be used to determine whether the respiratory response to question number 1 or the GSR in response to question number 5 have occurred because of their position in the series or were genuine responses to the questions themselves.

[[Key to Fig. 50: POT response example]

(9) Example 9

Number 3 is the critical question in Figure 51. Beginning with the question immediately after the critical question, the respiratory wave becomes suppressed. Approximately the same size GSRs appear in response to the critical question as to question number 5. At the critical question the pulse wave baseline rises. This change continues even after question number 5. In a case such as this, where changes occur in every indicator both with questions number 3 and number 5, another test is given in which their positions are altered .

[[Key to Fig. 51: POT response example]

(10) Example 10

Number 3 is the critical question in Figure 52. This test was performed on the same examinee as in Figure 51 with the same questionnaire. Only the order of presentation of the questions is different. Both respiratory amplitude and cycle slow slightly until the critical question is presented. In response to the critical question, a prominent GSR appears, as it does to question number 4. A slight decrease of pulse wave amplitude as well as a slight rise in the pulse wave baseline are observed in response to the critical question. However, these are not considered specific. Responses are not replicated to any of the indicators that appear in response to question number 5 in the previous record. Because the critical question elicits responses in two indicators, a decision is reached to the effect that "specific responses were observed."

3. Control question test

In CQT, questions are presented in a questionnaire consisting of relevant, irrelevant, and control questions (which includes questions about a hypothetical crime) arranged in a certain way. Examinees' guilty consciences are detected through physiological responses expressed as changes in their emotional reactions. Direct questioning as to whether examinees feel guilty or not about the crime are

possible with this method. With this method it is also possible to prepare questions related to the examinees' degree of involvement with the crime. Further, contents of relative questions (including questions about hypothetical crimes) can be selected depending on the degree of the examinees' participation in the crime.

3.1 Construction of questions

3.1.1 Construction of questions illustrated by examples

(1) Example

"Between approximately 11 p.m. on March 3 and 6 a.m. on the 4th, someone snuck into pawnshop I, located in 3-chome, Honcho, and escaped with jewelry and 100,000 yen in cash." These facts were widely reported in newspapers and TV reports.

The examinee, 21 year old Y, an employee of a "pachinko" parlor [electronic pinball game shop] and a resident of the Chuo Apartment in 1-chome, Chuocho, of the city, was arrested when he appeared at a jeweler's to sell the stolen jewelry. His permanent domicile is in A City.

(2) Listed below is a CQT questionnaire made according to the standard order of arrangement presently in use.

1 Are you Mr Y?

2 Were you born in the Showa era?

@ 3 Do you know the criminal who snuck into the pawnshop in 3-chome, Honcho on the night of March 3?
(Do you know who snuck into the pawnshop I?)

4 Do you live in Chuocho?

@ 5 Did you sneak into the pawnshop I and steal 100,000 yen in cash and other things?

o 6 Have you ever stolen gifts [prizes for scoring game] at the pachinko parlor where you work?

7 Do you live in an apartment in Chuocho?

8 On the night of February 28 did you sneak into the drugstore K, located in 1-chome Honcho,?

@ 9 Did you sneak into the pawnshop I?

10 Is your permanent domicile in A City?

(Marks in front of questions: @, relevant; o, control; #, hypothetical; irrelevant question are unmarked)

(3) The relevant question number 3, asks if the examinee knows the person who has committed the crime. Relevant questions number 5 and number 9 ask if the examinee has participated in the crime.

Control question number 6, is concerned with a fact which was confirmed by the investigator yet firmly denied by the examinee.

Hypothetical question number 8 asks about a crime hypothetically set up by the examiner.

3.1.2 Addition of relevant questions

In preparing a questionnaire, more relevant questions can be added to a standard CQT. In the example in 3.1.1, the following two questions are added as questions number 10 and number 11, leaving the other nine questions as they are.

10 Did you go the pawnshop I the same night that it was burglarized?
(The examinee answered in the negative.)

11 Have you lied to the questions given so far?

3.2 Irrelevant questions

3.2.1 Significance

(1) When a series of stimuli are presented, records of measured physiological responses show prominent responses to the first stimulus, regardless of its nature. In order to elicit this response, the so-called position response, irrelevant questions are placed at the beginning of a question list.

(2) If relevant, control, and hypothetical questions are presented

sequentially, responses to them may overlap. Irrelevant questions are interspersed to buffer this effect.

3.2.2 Contents

In the example of 2.1.1 [sic.: 3.1.1?], numbers 1, 2, 4, and 7 are irrelevant questions. Personal matters concerning examinees, e.g. name, age, or address, are used generally as irrelevant questions.

Necessary items are copied beforehand from examinees' deposition later to be confirmed with examinees themselves at the time of interview.

3.2.3 Basic conditions

(1) Irrelevant questions use already known facts. Questions examiners merely assume to be factual should not be used. Even with such a matter as age or name, examinees do not necessarily answer truthfully. Therefore, if not confirmed, the form of question such as "were you born in the Showa era?" or "are you called Mr Y?" should be used, instead of asking "are you 21 years old?" or "are you Mr Y?"

(2) When using unconfirmed materials, it should be kept in mind that examinees occasionally attempt to test the reliability of the polygraph test by intentionally giving false answers. As a result, relatively great responses may appear to questions the examiner has set up as irrelevant questions. If this confuses the entire record

there is a danger that the comparison of responses to relevant, control, and hypothetical questions will be greatly hindered at the post-test stage of record examination.

(3) Irrelevant questions should be literally concerned with matters totally unrelated to the crime. That is, these questions should not arouse emotional reactions in examinees. Even though a personal topic, such as the name of the examinee's wife or a child, is used as an irrelevant question, it may act as a stimulus that evokes strong emotion. Matters that may divert the examinee's attention from relevant or control questions also are inappropriate. If a question concerning a hobby or personal taste is used as an irrelevant question, e.g. "Do you smoke?" or "Do you play golf?," examinees can disturb records by intentionally concentrating their attention on such a question.

3.2.4 Reading to examinees

(1) Examiners read contents of irrelevant questions to examinees in the same way as other questions are read and make sure that these are understood perfectly.

(2) Make clear that what examiners will present to examinees as irrelevant questions are limited only to those read to them; no other questions will be presented.

3.3 Relevant questions

3.3.1 Significance

Questions asked to evoke responses that provide clues in evaluation of whether examinees have a guilty conscience in regard to the crime which is the target of the test.

3.3.2 Contents

(1) In a standard CQT list, relevant questions are placed in the third, fifth, and ninth positions. Question contents are expressed with somewhat different nuances depending on their position.

(2) The relevant question in the third position takes a somewhat indirect expression. Namely, the question takes a form such as "Do you know the criminal?" The following are typical examples of questions asked in different categories of crimes.

(a) Theft: "Do you know the criminal who stole a television (last Saturday night) from the city office?

(b) Burglary: "Do you know the criminal who burglarized the gasoline station (the night of May 1) in Fujimicho?"

(c) Assault or murder: "Do you know who stabbed a taxicab driver

(about 11 p.m. on March 4) in front of the station?

(d) Rape: "Do you know who raped a young woman (the night of August 5) in a vacant lot behind the station?"

(e) Arson: "Do you know the criminal who set fire (last night) to the back entrance of inn H?"

(3) The relevant question in the fifth position is directly expressed. That is, it is expressed in such a way as "Did you do ...?" or "Was it you who did ...?" In contrast to the third question that asks about perception or knowledge about the criminal, the fifth question directly asks whether the examinee has participated in the crime. Typical questions are as follows:

(a) Theft: "Did you steal 680,000 yen in cash from the safe kept in the Accounting Section?"

(b) Burglary: "Did you burglarize grocery P?"

(c) Assault or murder: "Was it you who stabbed a young man in the tavern behind the station?"

(d) Rape: "Did you force a young woman whom you encountered on the street in Fujimicho to have intercourse?"

(e) Arson: "Was it you who set fire to the fuel storage of public bath T?"

(4) As with the fifth question, the ninth question is directly expressed. Compared to the fifth question, however, the intent here is to question from a different angle. Typical questions are as follows:

(a) Theft: "Did you sneak into a room on the first floor in the Green Mansion?" or "Do you know where the jewelry stolen from the Green Mansion is now?"

(b) Burglary: "Did you threaten a female salesperson pointing a knife at her in drugstore D?" or " Were you there when drugstore D was burglarized?"

(c) Assault or murder: "Did you fight with a young man wearing a leather jacket in the bar behind the station?" or "Do you know where the knife with which a young man was stabbed in the bar behind the station is at present?"

(d) Rape: "Did you hit a young woman whom you encountered on the street in Saiwaicho? or "Did you forcibly drag a woman in a blue coat into a vacant lot?"

(e) Arson: "At the time of a fire in tearoom S, did you see the

garbage dump flare up?" or "Did you set fire to old newspapers behind S?"

With the ninth question, a different way of expression should be devised while maintaining the connection to the contents of the third and the fifth questions. However, the expression should be closer to the contents of the fifth question, rather than taking the form of "Do you know ...?"

3.3.3 Basic conditions

(1) It is essential that a relevant question be easily understood. Questions are presented by reading from a list. Therefore, a relevant question must be understood completely upon hearing it once. If examinees misunderstand a question when it is read, the effect the relevant question is targeted to obtain cannot be expected.

(2) For the meaning of questions to be totally understandable, appropriate words must be chosen. Words used in daily life are easy to understand, because people hear them often. Therefore, during the interview that precedes questioning, sufficient attention must be paid to how the examinee expresses the contents of the crime. Words used by the examinees or expressions close to those used by them should be chosen in forming questions. In some cases, it may be necessary to explain the meaning of some words to examinees before questions are presented.

(3) Long questions should be avoided. With examinees who are hiding their crime, time needed to present a long question tends to blur the meaning of the question and, at the same time, weakens the impression it imparts. Even with examinees who are telling the truth about the crime targeted in the test, a long question may elicit confused responses. Prominent physiological responses may appear in the examinees as the result of aroused emotions, because they struggle when they have not understood a part of the question, or because they are answering hesitatingly, thinking that their answers might not be accurate.

When a long question must be asked, the question must be read and explained to the examinee before its presentation, so that the examinee will understand clearly the content of the crime under investigation. Otherwise, tell examinees beforehand that once recording of responses has started, questions will be presented in a shortened form; in practice, present only the essential part, omitting the preliminary part of the question.

(4) Contents of relevant questions must be limited to one single case. Simultaneous testing of mutually unrelated crimes is not effective. Examinees who have committed crimes repeatedly and are hiding them for personal reasons (which the examiner cannot imagine at all) occasionally concentrate their attention on one particular crime. In such a case, it is possible that prominent responses may occur only to questions relating to that particular crime, while no specific

responses appear to other crimes, even though they are hiding facts.

(5) Absolutely avoid asking a question with a double meaning. Questions such as "Did you hit a young man on the street or did you merely threaten him?" or "Did you forcibly take a handbook from the young woman after you hit her?" are examples. In answering a question that contains two types of deeds or events, the answer, "No," may be truthful to one part, but may be a lie to the other part.

(6) Materials that can be used as critical questions in POT should not be included in relevant questions. However, when many good materials for critical questions are available, it may sometimes be necessary to use them as relevant questions in order to reinforce relevant questions. For example, the question, "Did you sneak into bookstore H and steal 380,000 yen in cash?" is doubtlessly much clearer and gives a stronger impression than the question "Did you sneak into bookstore H?"

3.3.4 Reading to examinees

The examiner reads relevant questions to the examinee and makes certain that he/she has understood them completely before answering in the negative.

3.4 Control questions

3.4.1 Significance

When examinees are overly sensitive to external stimuli, responses may come from the presentation of the question itself rather than in response to a guilty conscience. Control questions are used to elicit responses that serve as criteria for evaluating whether or not responses to a relevant question are evoked from an examinee's guilty conscience.

3.4.2 Contents

No control question exists that can be used commonly in every type of polygraph test. Control questions need to be set up for individual cases.

3.4.3 Basic conditions

(1) Control questions should be concerning approximately the same quality of antisocial behavior as the crime being investigated.

(2) The most pertinent control questions are prepared using the type of materials next described. That is, the examinee has committed another crime, unrelated to the present one; this crime has been confirmed, but the examinee is not aware of the detection. Questions are prepared using these materials which have been developed in a pretest survey.

3.4.4 Setting up

Control questions are set up in such a way as to have examinees answer always in the negative. Also, question contents must have a high probability of making examinees give false answers.

3.4.5 Evaluation

(1) Examiner's intention in creating control questions is not only to ascertain facts, but also to have examinee's interests concentrated on the control question.

When giving false answers on the crime being tested, the examinee's interest in a relevant question is much higher than in a control question, even though the examiner has emphasized the latter's importance. Therefore, the examinee's false answer to a control question evokes relatively less prominent responses compared to his/her responses to a relevant question.

(2) With examinees who are answering truthfully about the crime being investigated, their interest focuses on the control question when contents of a control question is emphasized. As a consequence, when examinees who are truthful give false answers or are concerned as to whether their answer really is truthful or not, their responses appear specific in comparison to their responses to a relevant question. Thus, when evaluating responses to a relevant question, responses to a

control question serve as controls.

(3) Figure 53 is a test record of a case judged to be positive. This evaluation was later confirmed. Compared to responses to the control question (question number 6), responses to the relevant question (question number 5) are obviously specific.

[Key to Fig. 53: Responses to relevant question (breathing waves)]

(4) Figure 54 is a test record of a case judged to be negative. This evaluation was later confirmed. Compared to responses to the relevant question (question number 5), responses to the control question (question number 6) are about the same and cannot be called specific.

[Key to Fig. 54: Weak responses to the relevant and control questions]

(5) Figure 55 is a test record of a case judged to be negative. This evaluation was later confirmed. While responses to the relative question (question number 5) are prominent, responses to the control question (question number 6) are as prominent as the former.

[Key to Fig. 55: Responses to the control question (pulse wave)]

3.4.6 Reading to examinees

In the final stage of setting up the control questions, the examiner reads them to the examinee to ascertain that the examinee understands question contents completely; examinees are to answer in negative with a full understanding of contents.

3.5 Questions on a hypothetical crime

3.5.1 Significance

Even examinees who have nothing directly to do with the crime being investigated may become nervous, since the situation of being tested itself evokes anxiety. Consequently prominent responses may appear at the presentation of a relevant question itself. Questions on a hypothetical crime are used to differentiate this type of response from those elicited out of examinee's sense of guilt.

3.5.2 Contents

A hypothetical crime is set up; its contents become the source of questions.

3.5.3 The limit of application

The examiner must make the examinee's interest focus on the questions about the hypothetical crime, by emphasizing that it is an actual crime, circumstances about which cast suspicion on the examinee. So,

the hypothetical crime must not be of the nature that convinces the examinee that he/she could not have committed such a crime.

If the crime under investigation is of a type unlikely to be repeated, hypothetical questions cannot be applied. For example, an inappropriate example for an examinee who is under the suspicion of having set fire to the house owned by himself/herself aiming at insurance compensation, would be to ask hypothetical questions about "arson from a grudge." Also questions about a hypothetical case, "the murder of a woman who was attacked by a criminal with intent to rape her," are inappropriate to an examinee under suspicion of having murdered his lover. So, the application of CQT in these cases is quite difficult.

3.5.4 Introduction

(1) Effective application of hypothetical crime questions depends on thorough studies of question contents and the pretest introduction. When the examiner explains the content of control question lists to the examinee, sufficient time should be spent on contents of hypothetical crime questions. The examiner explains that, considering the pattern of crime and chronological and geographical conditions, there exists a high probability that they were committed by the same criminal.

(2) Contents of a hypothetical crime acts are factors heightening tension in examinees who are speaking truthfully regarding the crime being investigated. The majority of such examinees display agitation in speech or movements. So, examinees' attention will focus on the contents of hypothetical crime questions.

(3) Examinees who are hiding their criminal act calmly accept the contents of hypothetical crime questions. Their interest focuses only on the crime that they have actually committed. They are hardly interested in the hypothetical crime. Rather, they take a positive approach to hypothetical crime questions to which they can answer truthfully stating that "I had nothing to do with it."

3.5.5 Basic conditions

(1) For the contents of hypothetical crime questions, choose a crime similar to that under investigation. The contents need to be quite realistic for the examinee. While hypothetical, therefore, too obviously fantastic and artificial crimes must be avoided. For example, there is a likelihood that examinees would not perceive an atrocious hypothetical crime, such as a murder or a burglary/murder case, as real. If such a case really took place, the mass media would have reported it so prominently that the public would naturally know about it. Examinees must wonder why they are nevertheless being asked about a murder they have never heard of. So, when using an atrocious crime as a hypothetical crime question, care must be taken to make it

appear that the crime has occurred in a neighboring prefecture or that it happened several years ago so as to avoid skepticism on the part of the examinee.

(2) The hypothetical crime must be perceived by the examinee as of equal importance to the crime targeted for investigation. If the crime under investigation is burglary/murder, the hypothetical crime should not be a simple murder case. It should also be constructed as a case of burglary/murder. If the investigation concerns a petty swindle, the hypothetical crime also should be a case of petty swindling, not a marriage fraud or jumping a restaurant bill. For automobile theft, set up a case in which a car is stolen, not sneaking into a house or shoplifting.

(3) The commission of the crime as expressed in hypothetical crime questions must be logically seen by the examinee as feasible. Setting up of a crime that is supposed to have taken place while the examinee was sick and was hospitalized or during his/her stay abroad must absolutely be avoided.

(4) Contents of hypothetical crime questions need to be such that the examinee notices instantaneously that he/she has nothing to do with it. A relevant question when the case under investigation is "burglary," for example, is set up as "Did you sneak into a room on the first floor of the Fuji mansion and steal cash?" A hypothetical crime question in this case should be characterized by concrete facts.

For example, "Did you sneak into a drugstore behind the station and steal a cup made of pure gold?"

(5) Also, questions that refer to another crime the examinee may be suspected of having committed are not appropriate. That is to say, when the examinee is hiding his/her own crime and has committed another crime of the same mode of operation, the content of a hypothetical crime should not make the examinee think that it might have been his/her own crime.

3.5.6 Evaluation

(1) If procedures for setting up hypothetical crime questions as well as their execution have been followed accurately, the presence or absence of examinees guilty consciousness can be decided by comparing responses that appeared to hypothetical crime questions and those to relevant questions.

(2) When responses to hypothetical crime questions are specifically or approximately at the same level as responses to relevant questions, the indication is that the examinee does not feel guilty about the crime being investigated.

(3) When no responses at all appear to hypothetical crime questions or they are very small compared to responses to relevant questions, the indication is that the examinee feels guilty toward the crime

being investigated.

(4) Figure 56 is a test record of a case judged to be positive. This evaluation was later confirmed. Responses to the relevant question (question number 9) are obviously different from responses to the hypothetical crime question (question number 8).

[Key to Fig. 56: Responses to relevant question (3 indexes)]

(5) Figure 57 is a test record of a case judged to be negative. This evaluation was later confirmed. Responses to the hypothetical crime question (question number 8) are obviously different from responses to the relevant question (question number 9).

[Key to Fig. 57: Responses to hypothetical crime question (pulse wave)]

3.5.7 Reading to examinees

Examinees should not find out the contents of a hypothetical crime question only after question presentation session has begun. Question contents should be communicated beforehand. Even an examinee who has been hiding his/her own crime is familiar with the contents of a relevant question because the question contents have been fully explained. In contrast to this, when a hypothetical crime question is suddenly esented, relatively prominent physiological responses may

appear, triggered by the novelty of such a question acting as a strong stimulus. Therefore, when questions are introduced at the time of the interview, hypothetical crime questions are to be read to examinees in just the same way as other questions to ascertain that examinees are answering in the negative with a full understanding of contents.

3.6 Points to pay attention to in question presentation

3.6.1 Time interval

(1) The time interval for the presentation of questions is determined by index specific latency response (the time between the question presentation and the appearance of a response) and reaction time (the time between the response onset until the return to the preresponse level); indices are physiological responses to be measured and recorded. With the three indices employed in the present polygraphy tests, the standard time interval between questions ranges from 15 to 20 seconds.

(2) One exception is: After the presentation of the first, second, and tenth nonrelevant questions, the time interval of 5-10 seconds is acceptable. The main purpose of setting up the first and second questions is to accustom the examinee to the sequence of question-answer. Responses to these questions do not count as factors for decision making.

(3) The phenomenon of response elicitation is generally observed to the first and last questions, regardless of their contents. The tension to the words "The test has begun," in the first question, and the relief to the words "The test has come to end," in the last question, evoke emotive responses. Responses to questions in these positions need to be eliminated as objects for evaluation, or if used for decision making, the presence of this special phenomenon needs to be taken into consideration.

3.6.2 Influence of cuff pressure

One of the reasons for shortening the testing time is to minimize the time to apply the cuff pressure, used to pick up pulse wave measurements.

The cuff pressure at the level of 60-90 mm Hg must be applied to obtain optimum pulse wave recordings. If the cuff pressure is maintained for 4-5 minutes, the arm or hand may feel numbness, because the blood flow is suppressed. No pain should be felt. However, some examinees may complain of pain from fear of this strange sensation.

(2) [sic; skipped (1)?] In addition, once examinees find themselves in such a state, their attention may come to focus so much on the cuff pressure, and the sensation that arises from it, that they may not pay attention to questions presented by the examiner. Therefore, one of the conditions for effectively conducting polygraph tests is to

minimize the length of time cuff pressure is applied to examinees.

3.6.3 Confusing records

(1) Time intervals between question presentation should not be shortened beyond the necessary limit just for the consideration of minimizing the length of time cuff pressure is to be applied to examinees. Response records are disturbed especially when examinees have moved, coughed, or sighed. Therefore, a new question should not be presented until the record returns to the normal state.

(2) If record disturbance does not disappear quickly, bring the record back to the normal state by temporarily presenting a nonrelevant question before asking a relevant control or hypothetical question, ignoring the established order of presentation.

3.7 Examples of Response records

3.7.1 Negative evaluation

(1) In Figure 58 prominent GSRs appear to relevant questions (numbers 3, 5, and 9), control question (number 6), and hypothetical question (number 8). Hardly any pulse wave response appears. A suppressed breathing wave response appears to control question (number 6.) This examinee was evaluated as negative. This fact was later confirmed.

[Key to Fig. 58: Record of an examinee judged to be negative (1)]

(2) In Figure 59 prominent GSRs appear to relevant questions (numbers 5, and 9), control question (number 6), hypothetical question (number 8), and nonrelevant question (number 7.) While pulse wave responses appear to control question (number 6), hypothetical crime question (number 8), and relevant question (number 9), they are not considered to be specific suppressed breathing wave response appears to hypothetical crime question (number 8). This examinee was evaluated as negative. This fact was later confirmed.

[Key to Fig. 59: Record of an examinee judged to be negative (2)]

(3) In Figure 60 responses appear in breathing and pulse wave recordings to relevant questions (numbers 3 and 5). However, the same level of responses appear also to control question (number 6) both in breathing and pulse wave recordings. This examinee was evaluated to be negative. This fact was later confirmed.

[Key to Fig. 60: Record of an examinee judged to be negative (3)]

3.7.2 Positive evaluation

(1) In Figure 61 prominent responses appear in breathing and GSR recordings out of three indicators. While the baseline in breathing recordings is generally not stable, specific responses (block) appear to relevant questions (numbers 5 and 9). While suppressed responses appear to the control question (number 6) and hypothetical question (number 8), they cannot be called specific when compared to responses to relevant questions. Prominent GSRs appear to relevant questions (numbers 5 and 9.) This examinee was evaluated to be positive. This fact was later confirmed.

[Key to Fig. 61: Record of an examinee judged to be positive (1)]

(2) In Figure 62 almost no breathing wave response appears to any of the questions. However, specific GSR and pulse wave recordings appear to relevant questions (numbers 5 and 9). Pulse wave response to control question (number 6) and hypothetical crime question (number 8) cannot be called prominent when compared to responses to relevant questions (especially number 5). This examinee was evaluated to be positive. This fact was later confirmed.

[Key to Fig. 62: Record of an examinee judged to be positive (2)]

(3) In Figure 63 prominent responses appear to all three indices, breathing, GSR, and pulse wave recordings. Responses to relevant

questions (especially to number 5) are prominent, typical specific responses.

[Key to Fig. 63: Record of an examinee judged to be positive (3)]